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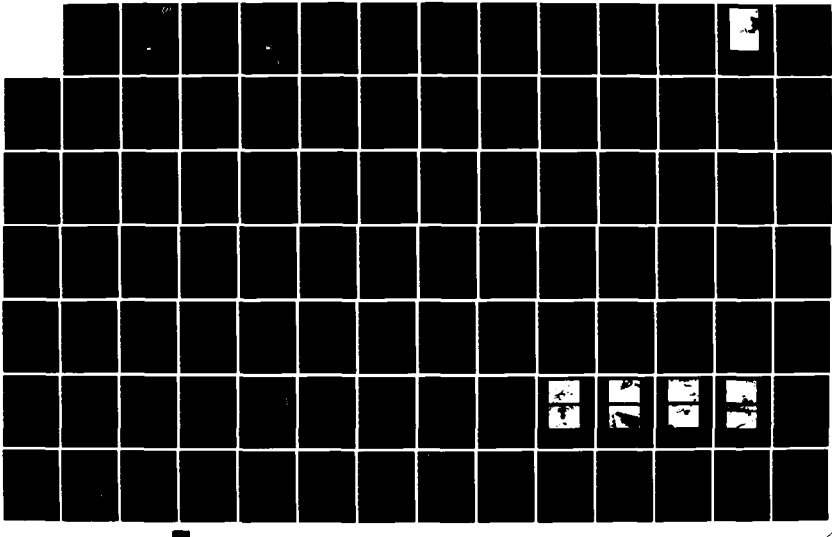

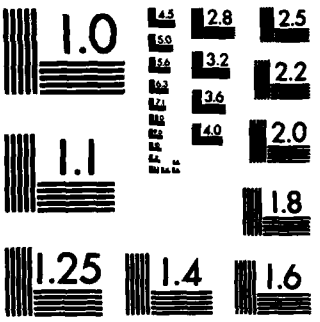

THAMES RIVER BASIN
SPRAGUE, CONNECTICUT

HANOVER RESERVOIR DAM
CT 00470

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST, 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE August, 1980 13. NUMBER OF PAGES 65
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Thames River Basin
Sprague, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The project, is an earth embankment approximately 26.5 feet in height and 750 ft. in length including a 147 foot long masonry spillway. Based upon the visual inspection at the site and apst performance, the project is judged to be in poor condition. In accordance with Army Corps of Engineers' guidelines, Hanover Reservoir Dam is classified as a significant hazard, small size dam. The test flood range to be considered is from the 100 year storm to one-half the PMF. The test flood for Hanover Reservoir Dam is equivalent to the ½ PMF.

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THAMES RIVER BASIN
SPRAGUE, CONNECTICUT

HANOVER RESERVOIR DAM
CT 00470

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST, 1980

BRIEF ASSESSMENT

PHASE 1 INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	Hanover Reservoir Dam
Inventory Number:	CT 00470
State:	Connecticut
County:	New London
Town:	Sprague
Stream:	Little River
Owners:	Raymond Armstrong
	R.E. Owens
	Charles Palmer
Date of Inspection:	June 2, 1980
Inspection Team:	Peter M. Heynen, P.E.
	Hector Moreno, P.E.
	Theodore Stevens
	Robert Jahn

The project, built around 1900, is an earth embankment approximately 26.5 feet in height and 750 feet in length including a 147 foot long masonry spillway. With the reservoir level to the top of the dam, the reservoir impounds approximately 400 acre-feet of water. The top of the embankment is 6.6 feet above the spillway crest and approximately 30 feet wide with a paved road on it. The broad crested masonry spillway is located at the left end of the dam and there is a 3 span steel bridge over the spillway approach channel. The outlet works, which have been abandoned, consist of a 54 inch diameter low-level outlet and a penstock.

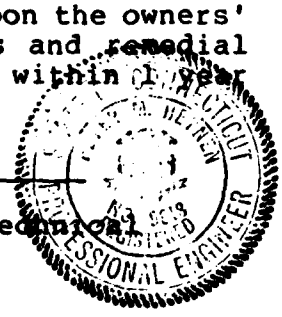
Based upon the visual inspection at the site and past performance, the project is judged to be in poor condition. There is substantial seepage emanating from 3 locations at the toe of the downstream slope, which requires monitoring. Items which require maintenance are the dense vegetation and debris on the dam, the irregular shape of the embankment, erosion of the upstream slope, deterioration of the masonry spillway training walls and erosion of the concrete bridge piers. The questionable condition of the outlet works requires further investigation.

In accordance with Army Corps of Engineers' guidelines, Hanover Reservoir Dam is classified as a significant hazard, small size dam. The test flood range to be considered is from the 100 year storm to one-half the Probable Maximum Flood (PMF). The test flood for Hanover Reservoir Dam is equivalent to the one-half PMF. Peak inflow is 10,800 cubic feet per second (cfs); peak outflow is 10,700 cfs with the dam overtopped by 1.5 feet. The spillway capacity, with the reservoir level to the top of the dam, is 5,600 cfs, which is equivalent to 52% of the routed test flood outflow.

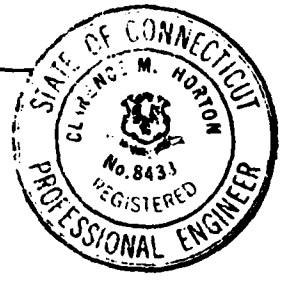
It is recommended that the owners retain the services of a registered professional engineer to formulate recommendations concerning repair or replacement of the low-level outlet, and removal of trees and debris from the dam, and to investigate the origin and significance of seepage through the dam. Recommendations made by the engineer should be implemented by the owner.

The above recommendations should be initiated upon the owners' receipt of this report, and further recommendations and remedial measures presented in Section 7 should be initiated within 1 year of the owners' receipt of this report.

Peter M. Heynen, P.E.
Project Manager - Geotechnical
Cahn Engineers, Inc.



C. Michael Horton, P.E.
Chief Engineer
Cahn Engineers, Inc.



This Phase I Inspection Report on Hanover Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, Member
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, Member
Design Branch
Engineering Division

RICHARD DIBUONO, Chairman
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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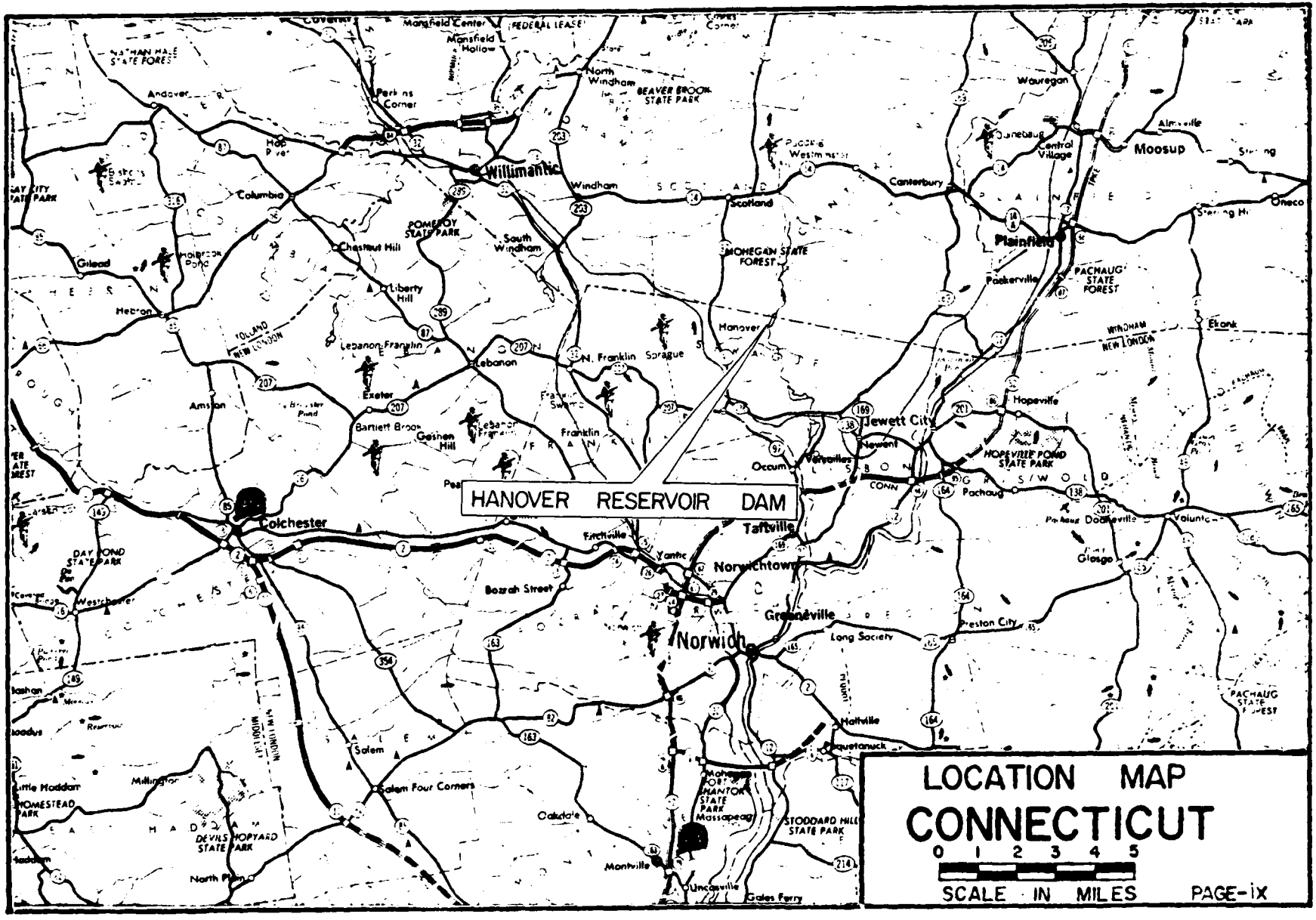
Overview Photo
February, 1980

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	Hanover Reservoir Dam
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	Little River Sprague, Conn. CE# 27 785 KB DATE July, '80 PAGE viii



LOCATION MAP
CONNECTICUT

0 1 2 3 4 5

SCALE IN MILES

PHASE I INSPECTION REPORT

HANOVER RESERVOIR DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of April 14, 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0052 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The dam is located on the Little River in a rural area of the Town of Sprague, County of New London, State of Connecticut. The dam is shown on the Scotland USGS Quadrangle Map having coordinates latitude N 41° 38.9' and longitude W 72° 03.8'.

b. Description of Dam and Appurtenances - As shown on Sheet B-1, the dam is an earth embankment, 26.5 feet in height and 750 feet in length, including a 147 foot long masonry spillway at the left end of the dam.

The top width of the embankment varies, but is generally between 30 and 35 feet except where it has been widened by dumping of fill on the downstream slope. A bituminous roadway, approximately 18 feet in width, runs along the upstream half of the top of the embankment and a 3 span steel bridge crosses the spillway approach channel. The top of the embankment, at elevation 189.6 (assumed NGVD datum - See Notes Sheet B-1), is 6.6 feet above the spillway crest, except where it slopes up to the deck of the bridge, at elevation 192.3. The upstream slope, which has no riprap, is at an inclination of approximately 1.5 horizontal to 1 vertical. The downstream slope is highly variable in inclination due to the dumping of miscellaneous fill on the slope, but appears to have an original design inclination of approximately 1.3 horizontal to 1 vertical.

The 147 foot long spillway, with a crest elevation of 183.0, is a broad-crested masonry weir with a concrete splash apron. The spillway has masonry training walls which serve as bridge abutments and there are two concrete bridge piers in the spillway approach channel.

The abandoned low-level outlet works and penstock are located at the right end of the dam. The low-level outlet is a 54 inch diameter steel pipe with an approximate invert elevation of 164.3. The intake structure for the low-level outlet is constructed of masonry and concrete and located on the upstream slope of the dam. The penstock to an old mill 1000 feet from the dam has been dismantled. The penstock intake structure, with a 5 foot by 7 foot inlet opening, is constructed of concrete and located on the upstream slope adjacent to the low-level intake structure.

c. Size Classification - (SMALL) - The dam impounds approximately 400 acre-feet of water with the reservoir level to the top of the dam which is approximately 26.5 feet above the old streambed of the Little River.

According to the Army Corps of Engineers' Recommended Guidelines, a dam of this height and maximum storage is classified as small in size.

d. Hazard Classification - (SIGNIFICANT) - If the dam were breached, there is potential for property damage along an approximately 2 mile reach of the Little River valley between Hanover Reservoir and Paper Mill Pond, including a road bridge on Potash Hill Road and an earth embankment dam at Paper Mill Pond. Also, there exists the possibility for loss of a few lives in the area flooded by a breach of the dam.

e. Ownership - Mr. Raymond L. Armstrong
Mission Street
Hanover, Ct. 06350
(203) 822-8541

Mr. R. E. Owens
Sheraton Lane
Norwich, Ct. 06360
(203) 889-7680

Mr. Charles Palmer
River Road
Lisbon, Ct. 06351
(203) 887-5592

The dam was previously owned by the Angus Park Woolen Company which went out of business in 1974.

f. Operator - None

g. Purpose of Dam - Prior to 1974, the reservoir was used to supply water to the woolen factory and to portions of the Village of Hanover. It no longer serves any specific purpose, but people do use it for recreational activities, such as fishing, and developers are selling residential building lots adjacent to the reservoir.

h. Design and Construction History - According to Town officials, the dam was built around 1900, but nothing specific concerning design or construction is known, nor is it known if there were any later alterations or repairs to the structure.

i. Normal Operational Procedures - There are no operational procedures followed at the dam. The roadway and bridge are maintained by the Town of Sprague.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area is 33.3 square miles of mostly undeveloped, wooded, rolling terrain.

b. Discharge at Damsite - Discharge is over the spillway.

1. Outlet works (conduits):
54 inch low-level outlet @ invert el. 164.5±: Inoperable gate - condition unknown

2. Maximum flood at damsite:	1400 cfs (August 19, 1955) - Overtopping prevented by sandbagging
3. Ungated spillway capacity @ top of dam el. 189.6:	5600 cfs
4. Ungated spillway capacity @ test flood el 191.1:	7600 cfs
5. Gated spillway capacity @ normal pool:	N/A
6. Gated spillway capacity @ test flood:	N/A
7. Total spillway capacity @ test flood el. 191.1:	7600 cfs
8. Total project discharge @ top of dam el. 189.6:	5600 cfs
9. Total project discharge @ test flood el. 191.1:	10,700 cfs

c. Elevations - Elevatons are approximate NGVD based on an assumed spillway crest elevation of 183.0.

1. Streambed at toe of dam:	163.1±
2. Bottom of cutoff:	N/A
3. Maximum tailwater:	N/A
4. Normal pool:	183.5±
5. Full flood control pool:	N/A
6. Spillway crest (ungated):	183.0±
7. Design surcharge (original design):	Not Known
8. Top of dam:	189.6±
9. Test flood surcharge:	191.1

d. Reservoir Length

1. Normal pool:	1700± ft.
2. Flood control pool:	N/A
3. Spillway crest pool:	1700± ft.
4. Top of dam pool:	3000± ft.
5. Test flood pool:	3600± ft.

e. Reservoir Storage

1. Normal pool:	210± acre-ft.
2. Flood control pool:	N/A
3. Spillway crest pool:	210± acre-ft.
4. Top of dam pool:	400± acre-ft.
5. Test flood pool:	450± acre-ft.

f. Reservoir Surface

1. Normal pool:	16.5± acres
2. Flood control pool:	N/A
3. Spillway crest pool:	16.5± acres
4. Top of dam pool:	34.0± acres
5. Test flood pool:	36.0± acres

g. Dam

1. Type:	Earth embankment
2. Length:	750± ft.
3. Height:	26.5± ft.
4. Top width:	30-35 ft.
5. Side slopes:	Irregular downstream 1.5±H to 1V upstream
6. Zoning:	N/A
7. Impervious core:	N/A
8. Cutoff:	N/A
9. Grout curtain:	N/A
10. Other:	N/A

h. Diversion and Regulating Tunnel - N/A

i. Spillway

1. Type:	Broad-crested masonry with concrete splash apron

2.	Length of weir:	147 ft.
3.	Crest elevation:	183.0 (assumed NGVD datum)
4.	Gates:	N/A
5.	Upstream channel:	Shallow, sandy bottom
6.	Downstream channel:	Shallow, boulders, cobbles
7.	General:	N/A

j. Regulating Outlets

Low-level outlet (abandoned)

1.	Invert:	164.5±
2.	Size:	54 in. dia.
3.	Description:	Steel pipe
4.	Control mechanism:	None
5.	Other:	Not operable - appears to be abandoned

SECTION 2: ENGINEERING DATA

2.1 DESIGN DATA

The available data consists of inventory data by the State of Connecticut, several inspection reports by the State, and correspondence between the State and the former owner concerning the condition of the dam (See Appendix B).

2.2 CONSTRUCTION DATA

No information was available.

2.3 OPERATIONS DATA

No formal operations records are known to exist. Reportedly, the dam was nearly overtopped during the storm of August, 1955, but overtopping at a low point near the right end of the dam was prevented by the placement of sandbags.

Between 1963 and 1980, several inspections of the dam were performed by or for the State of Connecticut and recommendations were made for repair of the dam. During this period, much correspondence was written concerning planned repairs to the dam, but no repairs were ever performed.

2.4 EVALUATION OF DATA

a. Existing Data - Existing data was provided by the State of Connecticut Department of Environmental Protection. The owner made the project available for visual inspection.

b. Adequacy - There was no detailed engineering data available; therefore, the final assessment of this project must be based on visual inspection, performance history, hydraulic computations of spillway capacity, and hydrologic estimates.

c. Validity - A comparison of record data and visual observations reveals no significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the project is poor. The inspection revealed several areas requiring maintenance, repair, and monitoring. At the time of inspection, the reservoir level was at elevation 183.2; i.e. 0.2 foot above the spillway crest.

d. Dam

Top of Dam - The upstream half of the top of the embankment is covered by an 18 foot wide bituminous roadway. The pavement is in fair condiiton, with some cracking, but no signs of movement or settlement. Some of the guardrail posts along the road are tipped and the cables loose. There is no guardrail along much of the downstream side of the road. There are many trees with trunk diameters of up to 15 inches or more, underbrush, and weeds on the downstream half of the top of the embankment, as well as miscellaneous fill in some places, which causes the top width of the dam to be very irregular (See Sheet B-1).

Upstream Slope - The upstream slope of the embankment is generally at an inclination of approximately 1.5 horizontal to 1 vertical and does not have any riprap. An approximately 2 foot high strip immediately above the normal reservoir level appears to have been eroded and is at an inclination of approximately 1 horizontal to 1.2 vertical. Below the normal reservoir level, the slope was measured to be inclined at approximately 3 horizontal to 1 vertical. Trees, brush and weeds are also present on the upstream slope.

Downstream Slope - Downstream slope inclinations vary widely due to dumping of miscellaneous fill such as boulders, gravel, stumps, branches, tires and other debris on the slope. In an area where no dumping has occurred, the slope was measured to have an inclination of approximately 1.3 horizontal to 1 vertical. Trees, with trunk diameters of up to 15 inches or more, are numerous on the downstream slope and there is heavy brush growth as well (Photo 3).

There are 3 large wet areas, as shown on Sheet B-1, at the toe of the dam, but, due to the amount of debris at the toe, no seeps exiting from the embankment were located. Water in the wet area closest to the left end of the dam, approximately 160 feet from the spillway, is nearly stagnant and a very soft, compressible soil condition exists in this area (Photo 1). The soil at the center wet area is also soft and compressible, but water in this area is flowing away from the toe in a shallow, 6 foot wide swale (Photo 2). The wet area at the right end of the dam appears to be approximately 3 feet deep and stagnant. A small flow through the low-level outlet pipe was observed (Photo 5) but it could not be seen if there were other seeps contributing to this wet area and no outlet from the wet area was observed. Surrounding the wet area adjacent to the low-level outlet pipe are berms an a masonry weir, apparently designed to direct outflow from the outlet away from the toe of the dam and/or away from the penstock.

Spillway - The masonry spillway crest is in good condition. No substantial obstructions of the shallow, sand bottomed approach channel or crest were observed, though two rather large tree trunks were observed on the spillway crest (Photo 4). The concrete splash apron appears to be in good condition, with only minor cracking at the construction joints. There are overhanging trees and a small island in the broad, cobble and boulder bottomed downstream channel; however, the channel is large and these minor obstructions would not significantly lessen its effectiveness under high discharges. The masonry spillway training walls are in fair condition, with cracking and leaching of the mortar joints, particularly at the normal pool elevation.

c. Appurtenant Structures - The low-level outlet appears to be inoperable, as the gate stem is badly misaligned. The size and composition of the intake gate are not known, but it is evidently leaking as there is seepage emanating from the 54 inch outlet pipe. The intake structure, constructed of masonry with a concrete coping is in poor condition, exhibiting cracking and displacement of the concrete (Photo 6). There is no headwall or discharge channel for the outlet pipe, which discharges into the wet, swampy area at the toe of the dam (Photo 5).

The condition of the abandoned penstock through the embankment is not known. The concrete intake structure is in good condition (Photo 6). The gate is 7 feet wide by 5 feet deep and is located in a slot approximately 3 feet from the upstream edge of the penstock intake structure. At the upstream edge of the structure is a steel trash rack, which is presently covered by plywood. The portion of the penstock from the dam to the old factory has been entirely dismantled and its point of exit from the embankment could not be found, apparently having been covered with soil and revegetated. There is a 3-4 foot deep by 2 foot wide cavity in the downstream slope along the alignment of the penstock (Photo 7), which was apparently a vent for the approximately 1000 foot long penstock (Appendix B-35).

The 3 span steel bridge over the spillway approach channel is in fair condition, but the 2 concrete support piers are very badly spalled and in poor condition. The steel beams and guard rails, and the bridge deck appear to be in good condition. The spillway training walls which also serve as bridge abutments are in fair condiion, as previously described.

d. Reservoir Area - The area surrounding the reservoir is wooded and undeveloped.

e. Downstream Channel - The downstream channel is the natural streambed of the Little River. It is broad and shallow to the initial impact area.

3.2 EVALUATION

Based upon the visual inspection, the project is assessed as being generally in poor condition. The manner in which the

features identified in Section 3.1 could influence the future condition and/or stability of the project is as follows:

1. Large trees on the top and slopes of the dam could be uprooted, causing extensive damage to the dam. Penetration of the root systems may further increase seepage through the dam.

2. The dumping of miscellaneous fill on the downstream slope of the dam obscures the true configuration and condition of the dam and prevents monitoring of seepage. In many places, the fill is resting at nearly vertical inclinations and is liable to slide, causing damage to the dam.

3. The upstream slope of the dam is likely to be further eroded, due to the lack of riprap protection.

4. Seepage at the toe of the dam could worsen and lead to stability problems

5. Further deterioration of the masonry spillway training walls or concrete bridge piers cause instability of the bridge.

6. The lack of an operational low-level outlet prevents lowering of the reservoir level in the event of an emergency at the dam.

7. Further deterioration of the low-level intake structure could threaten its stability and possibly cause partial blockage of the intake channel.

8. The condition of the abandoned penstock through the dam is not known and the cavity on the downstream slope may be an indication of partial collapse of the penstock

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 OPERATIONAL PROCEDURES

a. General - There are no formal regulating procedures followed at the dam.

b. Description of Any Formal Warning System In Effect -No formal warning system is in effect.

4.2 MAINTENANCE PROCEDURES

a. General - Other than the maintenance of the roadway by the Town of Sprague, there is no formal program of maintenance or inspection at the dam.

b. Operating Facilities - No formal program for maintenance of operating facilities is in effect.

4.3 EVALUATION

Operation and maintenance procedures are non-existent. A formal program of operation and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Also, a formal warning system should be developed and implemented within the time frame indicated in Section 7.1c. Remedial operation and maintenance recommendations are presented in Section 7.3.

SECTION 5: EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 GENERAL

The watershed is 33.3 square miles of mostly undeveloped, wooded, flat to rolling terrain, including several large swamps. Hampton Reservoir and Pine Acres Lake, both located in the upper reaches of the watershed, have a negligible, if any, effect on the reduction of peak inflows to Hanover Reservoir.

The dam is a low surcharge storage, low spillage type project. The available storage reduces the outflow from a Probable Maximum Flood (PMF) of 21,600 cubic feet per second (cfs) to 21,400 cfs and the ½ PMF outflow from 10,800 cfs to 10,700 cfs.

5.2 DESIGN DATA

No computations could be found for the original design of the dam.

5.3 EXPERIENCE DATA

A low area near the right end of the dam was nearly overtopped during the storm of August, 1955, but overtopping was prevented by the placement of sandbags.

At a gaging station 1.7 miles north of Hanover Reservoir, a maximum flow of 1400 cfs was recorded on August 19, 1955 (Appendix B-32).

5.4 VISUAL OBSERVATIONS

No unusual hydrologic features of the project were observed.

5.5 TEST FLOOD ANALYSIS

Based upon the U.S. Army Corps of Engineers' "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March 1978, the watershed classification (flat to rolling), and a watershed area of 33.3 square miles, a PMF of 21,600 cfs is estimated at the dam site. The range of test floods to be considered for this significant hazard, small size dam is from the 100 year storm to ½ PMF. The hazard associated with a breach of the dam is primarily economic, with a possibility for loss of a few lives. Therefore, the test flood is equivalent to the ½ PMF. The initial reservoir level is assumed to be 0.5 foot above the spillway crest elevation of 183.0. Peak inflow at test flood is 10,800 cfs. Because of the small surcharge storage (Appendix D-5), the peak outflow for the test flood is estimated at 10,700 cfs and this flow will overtop the dam by 1.5 feet. Based on hydraulics computations, the spillway capacity to the top of the dam is 5,600 cfs, which is equivalent to 52% of the routed test flood outflow.

5.6 DAM FAILURE ANALYSIS

The dam failure analysis is based on the April, 1978 Army Corps of Engineers "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs." With the prefailure reservoir level at the top of the dam, peak outflow would be about 5,600 cfs and the peak failure outflow from a breach of the dam would total about 72,000 cfs (D-8). This flood flow will be greatly reduced by the available channel storage between Hanover Reservoir Dam and Paper Mill Pond. However, the breach of the dam would result in a rise in the water level of the stream from a depth of 2.2 feet just before the breach, to a depth which will vary along the reach from about 11.7 feet leaving the dam to 2.6 feet entering Paper Mill Pond. This rapid, 9.5 to 0.4 feet increase in water level will inundate the Little River valley with subsequent economic loss and possibly causing the loss of a few lives. In addition, this flood would result in a 0.5 foot rise in the water level from elevation 116.3 to elevation 115.8 at Paper Mill Pond Dam, 10,000 feet downstream of Hanover Reservoir Dam. This sudden surge would reduce the freeboard on Paper Mill Pond Dam, which has a top elevation of 117.5, to less than one foot and could increase the potential for overtopping or wave action damage to the earth embankment portion of the dam. Based on the dam failure analysis, Hanover Reservoir Dam is classified as a significant hazard dam (Appendix D-11).

SECTION 6: EVALUATION OF STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

There are several areas of concern regarding the future stability of the structure. According to previous inspection reports, the stability of the downstream slope may be questionable, especially in light of the dumping of miscellaneous fill on the slope and the likelihood of trees on the slope becoming uprooted. More information on the soil characteristics of the slope is necessary to determine its stability and if flattening of the slope, as first recommended in 1963 by the State's engineers, is necessary. Even though the downstream slope is steeper than normal for an earth embankment, the top width of the dam is approximately 30 feet and the total width at the bottom of the dam is estimated to be 90 feet or more, which contributes to the stability of the structure.

The condition of the abandoned penstock through the dam and its gate could not be determined by visual inspection. If the penstock gate is not watertight, internal erosion of the embankment could occur and the penstock "vent" is an area which may be susceptible to collapse.

Other areas which may cause future stability problems are seepage, erosion of the bridge piers, erosion of the upstream slope, and deterioration of the spillway training walls.

6.2 DESIGN AND CONSTRUCTION DATA

No information was available.

6.3 POST-CONSTRUCTION CHANGES

There are no known post-construction changes to the dam.

6.4 SEISMIC STABILITY

The dam is in Seismic Zone 1 and, according to recommended guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon visual inspection of the site and past performance, the project appears to be in poor condition. There are several areas of the embankment and the bridge which require maintenance, repair and monitoring.

Based upon "Preliminary Guidance For Estimating Maximum Probable Discharges" dated March, 1978, the watershed area and classification, and hydraulic/hydrologic computations, peak inflow at test flood to the reservoir is 10,800 cfs: peak outflow is 10,700 cfs with the dam overtopped by 1.5 feet. The spillway capacity is 5,600 cfs which is equivalent to approximately 52% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the project must be based solely on visual inspection, past performance and sound engineering judgement.

c. Urgency - It is recommended that recommendations 1, 2 and 3 presented in Section 7.2 be initiated upon the owners receipt of this report. Recommendations 4, 5, 6 and 7 and the measures presented in Section 7.3 should be initiated within 1 year of the owners receipt of this report.

7.2 RECOMMENDATIONS

It is recommended that further studies be made by a registered professional engineer qualified in dam design and inspection pertaining to the following items. Recommendations made by the engineer should be implemented by the owners.

1. Repair or replacement of the low-level outlet facilities and intake structure.

2. Removal of all brush, trees and miscellaneous fill from the dam and from within 25 feet of the toe of the dam. This should include removal and proper backfilling of root systems, regrading and establishment of grassy vegetation on the embankment, and placement of riprap on the upstream slope. This work should be performed after the low-level outlet is repaired and the reservoir is drained.

3. Determination of the origin and significance of seepage through the embankment and if deemed necessary, development of recommendations to reduce or eliminate the seepage.

4. Determination of the condition of the abandoned penstock pipe, vent and gate.

5. An investigation and analysis of the stability of the embankment. If determined to be necessary on the basis of this investigation, flattening of the downstream slope or other measures to increase the stability of the project should be undertaken.

6. Detailed topographic survey of the project with preparation of a drawing for future reference.

7. A detailed hydraulic analysis of the adaquacy of the existing project discharge and outlet facilities.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken by the owners within the length of time indicated in section 7.1.c, and continued on a regular basis.

1. Round-the-clock surveillance should be provided during periods of heavy precipitation or high project discharge. A formal downstream warning system should be developed, to be used in case of emergencies at the dam.

2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference.

3. A comprehensive program of inspection by a registered professional engineer qualified in dam inspection should be instituted on an annual basis.

4. Seepage through the embankment should be monitored periodically to detect any possible changes in quantity or turbidity.

5. Cracked and eroded areas of the spillway training walls should be repaired.

6. Large logs and other debris should be cleared from the spillway crest.

The following measures should be undertaken by the Town of Sprague.

1. Erosion and undermining of the concrete bridge piers should be repaired when the reservoir level is lowered.

2. The guard rail along the roadway should be restored.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Hanover Reservoir Dam DATE: June 6, 1980

TIME: 2:30 pm

WEATHER: Overcast 75°

W.S. ELEV. 183.2 U.S. _____ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. Peter Heynen	PH	Geotechnical
2. Ted Stevens	TS	Geotechnical
3. Hector Morero	HM	Hydraulics
4. Robert John	RJ	Hydraulics
5. Tim Kavanaugh	TK	Survey
6. Moshé Norman	MN	Survey

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam Embankment	PH, TS, HM, RJ	Poor Condition
2.	Low-level Intake	PH, TS	Inoperable
3.	Penstock Intake	PH, TS	Abandoned
4.	Masonry Spillway	PH, TS, HM, RJ	
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT Hanover Reservoir Dam DATE 6-2-80

PROJECT FEATURE Dam Embankment BY PH, JS, HM, RJ

AREA EVALUATED		CONDITION
DAM EMBANKMENT		
Crest Elevation		189.6±
Current Pool Elevation		183.2
Maximum Impoundment to Date		Not known
Surface Cracks		Some - road
Pavement Condition		Fair - Macadam road
Movement or Settlement of Crest		None observed
Lateral Movement		Too irregular to judge
Vertical Alignment		
Horizontal Alignment		
Condition at Abutment and at Concrete Structures		Fair
Indications of Movement of Structural Items on Slopes		N/A
Trespassing on Slopes		None observed
Sloughing or Erosion of Slopes or Abutments		Sloughing and/or erosion of U/S slope
Rock Slope Protection-Riprap Failures		Riprap absent
Unusual Movement or Cracking at or Near Toes		None observed
Unusual Embankment or Downstream Seepage		3 major areas of seepage
Piping or Boils		None observed
Foundation Drainage Features		N/A
Toe Drains		N/A
Instrumentation System		N/A

PERIODIC INSPECTION CHECK LIST

PROJECT Hanover Reservoir Dam DATE 6-2-80

PROJECT FEATURE Low-level Intake BY PH,TS

AREA EVALUATED		CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE		
a) Approach Channel		Channel probed with survey rod - found to be ±14.5' deep. Felt like muddy bottom.
Slope Conditions		
Bottom Conditions		
Rock Slides or Falls		None
Log Boom		None
Debris		None
Condition of Concrete Lining		N/A
Drains or Weep Holes		N/A
b) Intake Structure		
Condition of Concrete		Fair - overgrown
Stop Logs and Slots		Gate closed, valve stem misaligned

PERIODIC INSPECTION CHECK LIST

PROJECT Hanover Reservoir Dam DATE 6-2-80

PROJECT FEATURE Penstock Intake BY PH, TS

AREA EVALUATED		CONDITION
OUTLET WORKS-INTAKE CHANNEL AND INTAKE STRUCTURE		
a) Approach Channel		Could not observe approach channel - probably just natural pond bottom.
Slope Conditions		
Bottom Conditions		
Rock Slides or Falls		
Log Boom		
Debris		
Condition of Concrete Lining		
Drains or Weep Holes		
b) Intake Structure		
Condition of Concrete		Fair - overgrown
Stop Logs and Slots		Plywood covering intake No gate operating mechanism in place Note: Penstock has been dismantled, but point of plug not known. There is a hole in the top of the pipe on D/S slope.

PERIODIC INSPECTION CHECK LIST

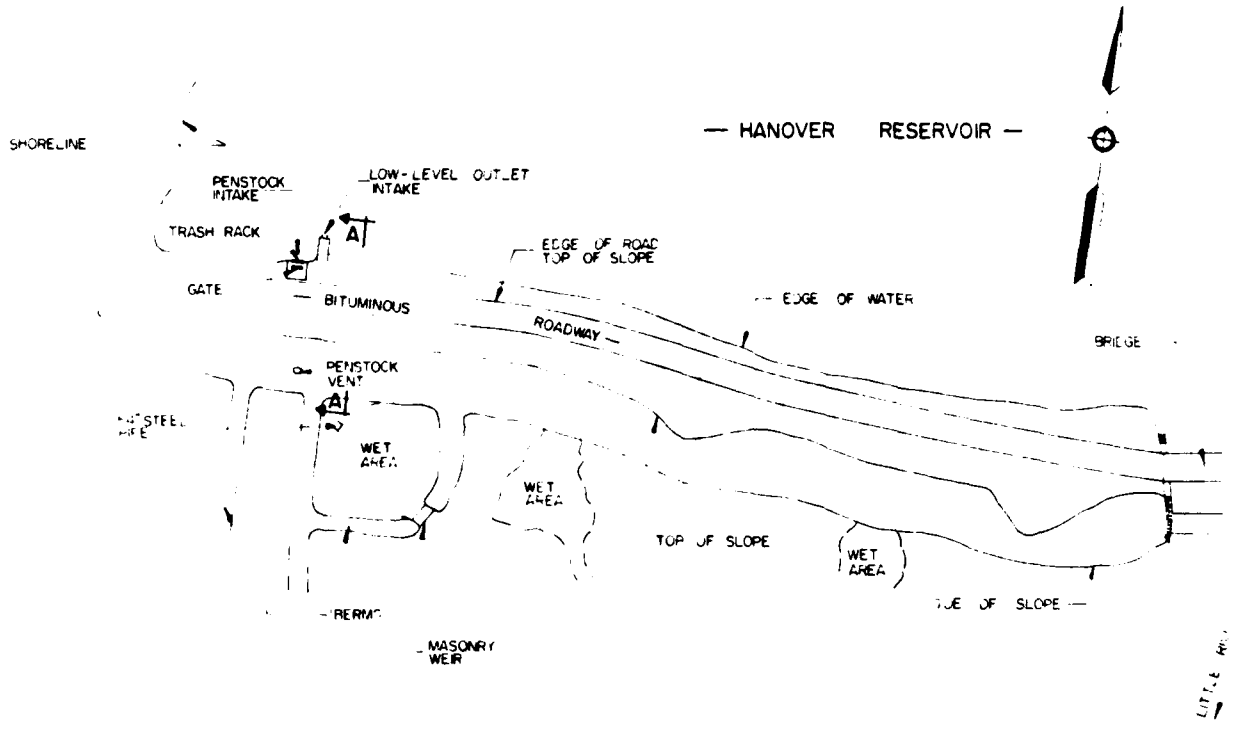
PROJECT Hanover Reservoir Dam DATE 6-2-80

PROJECT FEATURE Masonry Spillway BY DLT, WJT

AREA EVALUATED		CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a) Approach Channel		
General Condition		Fair, passes under bridge
Loose Rock Overhanging Channel		None observed
Trees Overhanging Channel		Yes - minor, but huge loss on crest at time of inspection
Floor of Approach Channel		Shallow, sandy
b) Weir and Training Walls		
General Condition of ~~Concrete~~ Masonry		Fair - minor cracking
Rust or Staining		None observed
Spalling		
Any Visible Reinforcing		
Any Seepage of Efflorescence		
Drain Holes		
c) Discharge Channel		
General Condition		Good
Loose Rock Overhanging Channel		None observed
Trees Overhanging Channel		Yes
Floor of Channel		Conc. apron to cobble channel
Other Obstructions		Island w/ trees

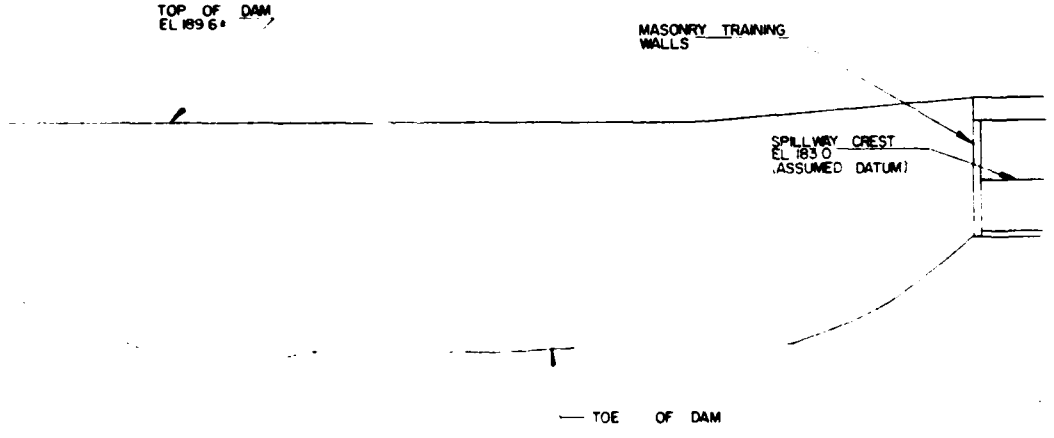
APPENDIX B

ENGINEERING DATA AND CORRESPONDENCE



PLAN

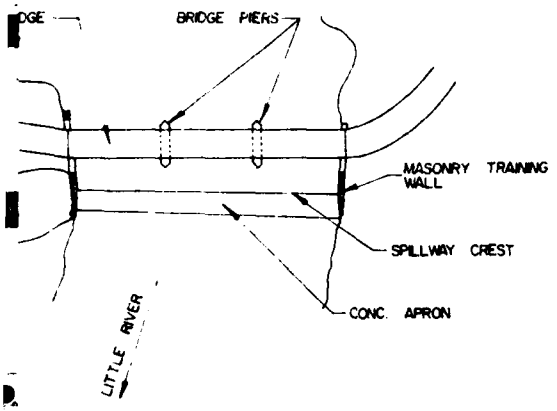
0 50 50

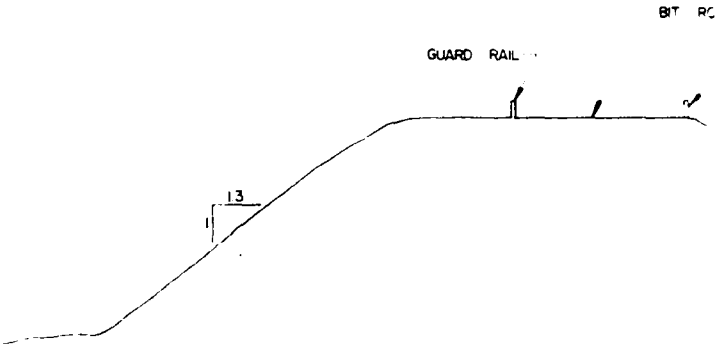


ELEVATION

50 0 50 100 HORIZONTAL

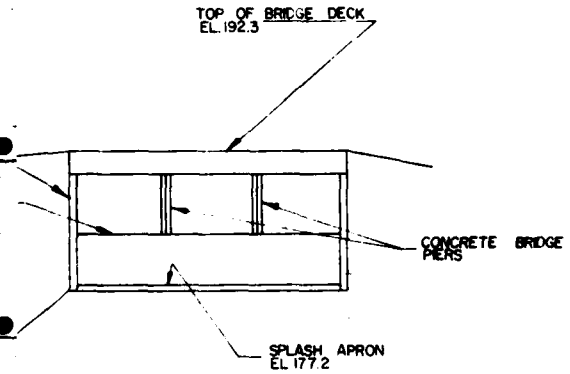
10 0 10 20 VERTICAL





SECTION A-A

10 0 10 20 (H & V



NOTES

1 THIS PLAN WAS COMPILED
INSPECTION OF THE DAM
DIMENSIONS SHOWN ARE APP
AND/OR STRUCTURAL FEATUR

2 NO ELEVATIONS WERE AVAIL
THE WATER SURFACE ELEV
RESERVOIR SHOWN ON THE
MAP WAS ASSUMED TO BE
SPILLWAY CREST
ALL OTHER ELEVATIONS SH
ASSUMED SPILLWAY CREST

CAMN ENGINEERS INC WALLINGFORD, CONNECTICUT ENGINEER	U S

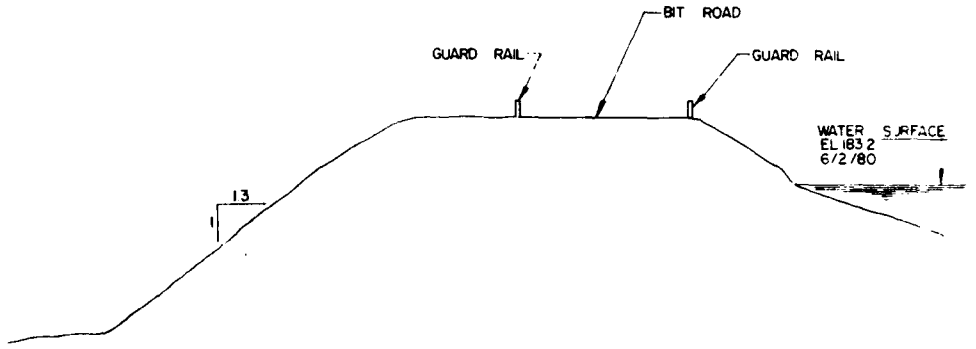
NATIONAL PROGRAM OF I

PLAN, ELEVATI

HANOVER RE

LITTLE RIVER

DRAWN BY	CHECKED BY	APPROVE
N. Norman		



MASONRY TRAINING WALL

SPILLWAY CREST

ONC APRON

SECTION A-A

10 0 10 20 (H & V)

CONCRETE BRIDGE PIERS

RON

NOTES

1. THIS PLAN WAS COMPILED FROM CAHN ENGINEERS INSPECTION OF THE DAM DATED JUNE 2, 1980. DIMENSIONS SHOWN ARE APPROXIMATE NOT ALL TOPOGRAPHIC AND/OR STRUCTURAL FEATURES ARE NECESSARILY IDENTIFIED

2. NO ELEVATIONS WERE AVAILABLE FOR THE DAM, THEREFORE THE WATER SURFACE ELEVATION OF 183.0 FOR THE RESERVOIR SHOWN ON THE U.S.G.S SCOTLAND QUADRANGLE MAP WAS ASSUMED TO BE THE N.G.V.D. ELEVATION OF THE SPILLWAY CREST.
ALL OTHER ELEVATIONS SHOWN ARE REFERENCED TO THE ASSUMED SPILLWAY CREST ELEVATION.

CAHN ENGINEERS INC. WALLINGFORD, CONNECTICUT ENGINEER	U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PLAN, ELEVATION AND SECTION

HANOVER RESERVOIR DAM

LITTLE RIVER SPRAGUE, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
N Norman			DATE JULY 1980	SHEET 8

SUMMARY OF DATA AND CORRESPONDENCE

DATE	TO	FROM	SUBJECT	PAGE
-	File	Water Resources Commission	Inventory Data	B-4
July 10, 1963	John J. Mozzochi & Assoc. 217 Hebron Ave. Glastonbury, Ct.	William P. Sander Engineer - Geologist Water Resources Comm.	Request for inspection of dam	B-5
July 15, 1963	William P. Sander	John J. Mozzochi	Inspection Report	B-6
Oct. 31, 1963	William P. Sander	William G. Park, President Angus Park Woolen Co.	Acknowledgement of letter of Oct. 29, 1963	B-8
Dec. 13, 1963	Angus Park Woolen Co.	Benjamin H. Palmer Chandler & Palmer Civil Engineers	Recommendations for repair of dam	B-9
May 7, 1965	John J. Mozzochi	William P. Sander	Request for reinspection of dam	B-10
June 29, 1965	William P. Sander	John J. Mozzochi	Inspection Report	B-11
March 27, 1969	William G. Park	William H. O'Brien III Civil Engineer Water Resources Comm.	Request to repair dam	B-12
April 14, 1969	William G. Park	Benjamin H. Palmer	Necessity of repairs to dam	B-14

DATE	TO	FROM	SUBJECT	PAGE
May 6, 1970	William H. O'Brien III	Angus W. Park President, Angus Park Woolen Co.	Reasons why trees had not been removed as scheduled	B-26
Oct. 17, 1974	Macchi Engineers 44 Gillett Street Hartford, Ct.	Victor F. Galgowski Supt. of Dam Maintenance Dept. of Environmental Protection State of Connecticut	Request for inspection of dam	B-28
Oct. 22, 1974	Victor F. Galgowski	Jose H. Cosio Macchi Engineers	Inspection Report, including sketches of dam and bridge	B-29
Jan. 17, 1980	Victor F. Galgowski	Charles J. Pelletier Consultant Dept. of Environmental Protection	Possible effects of failure of the dam	B-36
Jan. 21, 1980	Matthew T. Delaney First Selectman Baltic, Ct.	Victor F. Galgowski	Comment on condition of dam and downstream conditions	B-37

No. 5

Inventoried By _____

Date _____

WATER RESOURCES COMMISSION
SUPERVISION OF DAMS
INVENTORY DATA

2
CT-470

Name of Dam or Pond _____

Code No. S 2.9 LT 49

Nearest Street Location _____

Town _____

U.S.G.S. Quad. _____ Lat. 41°-38'-52" N

Name of Stream _____ Long. 72°-03'-48" W

Owner 1 P. Armstrong Owens MR. PALMER

Address ~~Jewett City Savings Bank~~ RAY ARMSTRONG - DAUT.
~~Jewett City CT 06351~~ OWENS. 7/75
888-9388

Pond Used For WATER POWER

Dimensions of Pond: Width _____ Length _____ Area 20A

18-702 Total Length of Dam _____ Length of Spillway _____

Location of Spillway _____

Height of Pond Above Stream Bed _____

Height of Embankment Above Spillway _____

Type of Spillway Construction _____

Type of Dike Construction _____

Downstream Conditions _____

Summary of File Data _____

Remarks _____

Class C

July 10, 1963

John J. Mozzochi and Associates
217 Hebron Avenue
Glastonbury, Connecticut

Re: Hanover Reservoir Dam
Sprague, Connecticut

Dear Sirs:

Under the terms of your contract as consultant to this Commission, please inspect the above mentioned dam and submit a report on its condition to this office.

The dam is located on the Scotland Quadrangle at approximately 41° 38' 52"N and 72° 03' 48"W. The inventory of dams by this office mentioned the following:

> "This dam is leaking at the base. It may be desirable to have an expert determine if this or any other condition is likely to lead to a damaging failure."

Very truly yours,

William P. Sandor
Engineer - Geologist

WPS:dlp

JOHN J. MOZZOCHI AND ASSOCIATES
CIVIL ENGINEERS

GLASTONBURY, CONN.
217 HEBRON AVENUE
PHONE MEDFORD 3-9401

PROVIDENCE 3, R. I.
200 DYER STREET
PHONE GAspee 1-0420

JOHN J. MOZZOCHI
ASSOCIATES
OWEN J. WHITE
JOHN LUCHS, JR.
ECTOR L. GIOVANNINI

July 15, 1963

REPLY TO: Glastonbury

William P. Sander-Engineer Geologist
Water Resources Commission
State Office Building
Hartford 15, Connecticut

Re: Our File 57-73-50
Hanover Reservoir Dam
Sprague, Connecticut

Dear Mr. Sander:

In accordance with your instructions of July 10th, I made an inspection of the referenced dam on July 11th and have the following to report:

1. The leaks noted at the base are of a minor nature and appear to be seepage through the foundation material rather than through the dam itself.

2. The dike portion of the dam carries a local road, Parkwood Road, and has a considerable number of large trees upon it. I recommend that all of the trees be removed from the dike.

3. The middle third section of the dike appears to have a downstream slope steeper than desirable. Since this occurs where the dam has its' greatest height, I recommend that additional stability and safety be achieved by flattening this slope.

Very truly yours,

John J. Mozzochi and Associates
Civil Engineers

JJM:hk

October 29, 1963

Angus Park Woolen Company
Hanover, Connecticut

Gentlemen:

This Commission is conducting an inventory of dams program throughout the entire State. The Hanover Reservoir Dam in the Town of Sprague was inspected recently and it was found that certain items of maintenance are necessary to place this structure in a safe condition.

Three items were noted:

1. There is leakage at the base of the dam.

2. There are a considerable number of trees on the dam. These trees must be removed.

3. The middle third section of the dike appears to have a downstream slope steeper than desirable. Since this occurs where the dam has its greatest height, it is recommended that additional stability and safety be achieved by flattening this slope.

Would you please inform this office within two weeks what steps your firm plans to take to repair this dam?

Very truly yours,

William R. Sander
Engineer - Geologist

WRS:dlp

THE ANGUS PARK WOOLEN CO., INC.

HANOVER, CONN.

822-8221

October 31, 1963

State of Connecticut
Water Resources Commission
State Office Building
Hartford 15, Connecticut

Attention: Mr. William P. Sander,
Engineer - Geologist

Gentlemen:

This will acknowledge your letter of October 29, 1963 in reference to certain items of maintenance which you feel are necessary in connection with the Hanover Reservoir Dam.

We have conferred with Benjamin H. Palmer of Chandler & Palmer, Engineers, of Norwich, Connecticut to examine the dam and make a report.

With reference to the second item noted we will take steps to have the trees on the dam removed this Fall.

Yours very truly,

ANGUS PARK WOOLEN CO., INC.

WGP/ab

William G. Park,
President

BENJAMIN H. PALMER
SHEPARD B. PALMER

CHANDLER & PALMER
CIVIL ENGINEERS
114-116 THAYER BUILDING
TELEPHONE 887-8640

DAMS
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MEMBERS AMERICAN AND CONNECTICUT SOCIETIES
OF CIVIL ENGINEERS

NORWICH, CONN.
December 13, 1963

12/17/63

Angus Park Woolen Company
Hanover, Connecticut

Re: Dam on Little River

Gentlemen:

This morning I made an inspection of your dam located on the Little River just above your mill. I have also read over the report sent to you by Mr. William P. Sander of the State Water Resources Commission.

In my opinion the most important item at the moment is for you to have the trees on the dam cut. The reason for this is that in the event of a high wind there is a possibility that the trees might blow over, causing the roots to open up a hole in the dam. I recommend that the trees at both the upstream and downstream side of the dam be cut fairly close to the ground and trees and brush removed. It is not necessary to remove the roots of the trees as they have a tendency to hold the soil in place.

There is some leakage below the dam but I think quite a bit of this is caused from springs and I could not see any leaks through the dam that appeared to be large enough to cause any trouble. I will inspect the dam from time to time during the winter and perhaps make some recommendations in the spring. I do not think there is any emergency at present as far as the leakage is concerned.

Mr. Sander's letter indicated that the downstream slope of the dam is steeper than desirable and I agree with him on this point. I think after the trees are removed perhaps next spring you should consider placing additional fill on the downstream side where the slopes are particularly steep. I do not think this is any emergency and I think this part of the work could go until next spring. The important thing at the moment is to get the trees and brush cleaned off as described above.

Very truly yours,

CHANDLER & PALMER

B. H. Palmer

B. H. Palmer

BHP/nir
cc: Mr. William P. Sander
Engineer-Geologist

May 7, 1965

John J. Mozzochi and Associates
217 Hebron Avenue
Glastonbury, Connecticut

Gentlemen:

Under the terms of your contract as consultant to this Commission will you please inspect and report on Hanover Reservoir Dam and Baltic Reservoir Dam, both in Sprague.

In 1963 you recommended certain repairs for these dams and we would like to know if these recommendations have been carried out and if they are satisfactory.

Very truly yours,

William P. Sander
Engineer-Geologist

WPS:dlp

JOHN J. MOZZOCHI AND ASSOCIATES
CIVIL ENGINEERS

JOHN J. MOZZOCHI
ASSOCIATES
OWEN J. WHITE
JOHN LUCHS, JR.
HECTOR L. GIOVANNINI

GLASTONBURY, CONN.
817 HEBRON AVENUE
PHONE 633-8401

PROVIDENCE 3, R. I.
100 DYER STREET
PHONE GASPEE 1-0420

REPLY TO: Glastonbury

June 29, 1965

William P. Sander-Engineer-Geologist
Water Resources Commission
State Office Building
Hartford 15, Connecticut

Re: Our File 57-73-50
Hanover Reservoir
Sprague

Dear Mr. Sander:

I have re-inspected this dam in accordance with your letter of May 7, 1965, and find that the conditions are the same as described in my letter of July 15, 1963.

Consequently my previous recommendations are still in order.

Very truly yours,

John J. Mozzochi and Associates
Civil Engineers

TJM:jhl

March 27, 1964

Angus Park Woolen Company, Inc.
c/o Mr. William G. Park, President
Hanover, Connecticut

Subject: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

The records in this office indicate that your company is the owner of the subject dam.

The Water Resources Commission has jurisdiction over all dams, dikes or similar structures "- - which, by breaking away or otherwise might endanger life or property - - ". This authority is established in the General Statutes of Connecticut, a copy of which is enclosed. The subject dam has been determined to be one "- - which, by breaking away or otherwise, might endanger life or property - - ", and is therefore under the jurisdiction of this Commission.

On October 29, 1963 we wrote yo you advising you of certain corrective work which was indicated by an inspection which we had made by an engineering consultant to this Commission. It was brought to your attention that leaks were noted at the base of the downstream slope. The following items were also specified:

1. "There are a considerable number of trees on the dam. These trees must be removed".

2. The middle third section of the dike appears to have a downstream slope steeper than desirable. Since this occurs where the dam has its greatest height, it is recommended that additional stability and safety be achieved by flattening this slope".

In your letter of October 31, 1963, you state that Benjamin Palmer was to examine the dam and make a report, and that steps would be taken to have the trees removed that fall.

Hanover, Connecticut

On March 26, 1969, this dam was inspected and it was found that the upstream and downstream slopes of this dam were still covered with large trees and the downstream slope still appeared steeper than desirable. In addition to this, the following item was noted:

3. Fill had apparently been dumped on the downstream slope on the east end making the slope even steeper than it had been. This practice, if continuing, should be discontinued as it increases the likelihood of a slide of the downstream embankment. Furthermore, this area should be re-graded to conform at least to the original slope if not made even flatter as suggested in #2.

If a report has been made by Mr. Palmer, we would ask that you send us a copy. If not, we request that you have such a report made on the safety of the dam by an engineer registered in the State of Connecticut and submit such a report by June 10, 1969. We also request that all trees on the water side and on the downstream slope be cut down by July 31, 1969 and that your engineer determine if it is necessary to also remove the root systems.

We request that you send us a written statement as to your intentions before April 16, 1969 and hope that more formal action will not be required.

Very truly yours,

William H. O'Brien III
Civil Engineer

Enc.

WHOIII:vhb

CHANDLER & PALMER
CIVIL ENGINEERS
114-116 THAYER BUILDING
TELEPHONE 887-5640

BENJAMIN H. PALMER
SHEPARD B. PALMER

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REPORTS
SURVEYS

MEMBERS AMERICAN AND CONNECTICUT SOCIETIES
OF CIVIL ENGINEERS

NORWICH, CONN. 06360

April 14, 1969

Angus Park Woolen Company
Hanover
Connecticut

Attention: Mr. William G. Park

Dear Mr. Park:

On December 13, 1963, I made an inspection of the Dam on Little River just above your mill and made a report to you at that time. I am enclosing a copy of that report.

On Friday, April 11th, 1969, I made a further inspection of the Dam and noted that none of the work had been done which was outlined in the letter.

I realize you are hesitant about cutting the trees on the Dam because of appearance. However, I do think there is some hazard from the possibility of wind blowing the trees over and opening up a hole in the Dam. I am assuming that you intend to get at this work as soon as possible.

Very truly yours,

B. H Palmer

Chandler & Palmer

BHP:mds
Enc.

ANGUS PARK WOOLEN CO., INC.

HANOVER, CONN. 06350

April 15, 1969

Water Resources Commission
State Office Building
Hartford, Connecticut 06115

Re: Hanover Reservoir Dam
Sprague

Attention: Mr. William H. O'Brien III
Civil Engineer

Gentlemen:

We have your letter of March 27, 1969 in further reference to the conditions at the above designated location.

We note that on October 29th, 1963 you wrote to us advising of certain corrective work which was indicated at this location. We further note that your engineers inspected this dam on October 26, 1969 and found the same conditions prevail as reported by you in 1963.

We fear we are the culprits in this situation, as you will note in the enclosed correspondence with Chandler & Palmer, Engineers of Norwich, Connecticut, that their 1963 report agreed substantially with the report of your engineers. Mr. Palmer has been absent from his office for some time and has only recently returned. You will note his letter of April 14, 1969 in which he refers to his 1963 inspection and also that of April 11th, 1969. In the final paragraph of his April 14th letter he puts his finger on the reason for the Company's reluctance to cut the trees on the dam. This reservoir is a beauty spot in the opinion of the Company, and to cut the trees down as requested would ruin the beauty of the spot. However, in view of the arguments in favor of the moving of the trees we will see that this work is accomplished as rapidly as possible.

Very truly yours,

ANGUS PARK WOOLEN CO., INC.

WGP/ab

William G. Park
President

April 21, 1969

Angus Park Woolen Co., Inc.
c/o Mr. William G. Park, President
Hanover, Connecticut

Subject: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

Thank you for your letter of April 15, 1969 with enclosed copies of reports by Chandler & Palmer on the subject dam, dated December 13, 1963 and April 14, 1969.

We note that you intend to remove the trees in accordance with the recommendations of both our consulting engineer and yours. This should be completed by July 31, 1969.

We request that plans be submitted for the flattening of the downstream slope, prepared by an engineer registered in the State of Connecticut and bearing his certification and seal. The engineer should check the overall safety of the structure and may feel that additional work should be performed to place the structure in a safe condition, in addition to the items brought out in our less detailed inspections.

May we hear from you at your earliest convenience as to your intentions?

Very truly yours,

William H. O'Brien III
Civil Engineer

WHOIII:vhb

July 24, 1969

Angus Park Woolen Co., Inc.
c/o Mr. William G. Park, Pres.
Hanover, Connecticut

Subject: Hanover Reservoir Dam
Sprague, Connecticut

Dear Mr. Park:

On April 21, 1969, we wrote to you requesting that the trees on the dam be cut down by July 31, 1969, and that plans be submitted by an engineer for the flattening of the downstream slope, (at least in the area where additional fill has been placed).

The first step is to have your engineer make an analysis of the safety of the dam with special emphasis on the steepness of the downstream embankment, and submit a report to us.

We would like a statement from you before August 12, 1969, about the trees and when we may expect an engineer's report on the safety of the dam.

Very truly yours,

William H. O'Brien III
Civil Engineer

WHOIII:vhb

ANGUS PARK WOOLEN CO., INC.

HANOVER, CONN. 06350

July 25, 1969

State of Connecticut,
Water Resources Commission
State Office Building
Hartford, Connecticut 06115

Attention: Mr. William H. O'Brien III,
Civil Engineer

Subject: Hanover Reservoir
Dam-Hanover, Conn.

Dear Mr. O'Brien:

We have your letter of April 21, 1969 in reference to the above subject.

Our engineers, Chandler & Palmer of Norwich, Connecticut, have inspected this dam several times and have on one or two occasions reported to your department in reference to their findings. Our engineers agree with you that this work should be done, but we would like to defer this matter until the Reservoir is frozen over. Our men feel that it would be much simpler to do the job then, and thus prevent discoloration which would result from cutting the trees at this time. We have been delinquent in not notifying you of this situation, and ask now that we be allowed to follow the above outlined plan.

Our engineers feel that it would be much better to work on the flattening of the downstream slope after the trees have been cut. We trust you would agree.

Very truly yours,

ANGUS PARK WOOLEN CO., INC.

William G. Park,
President

WGP/ab

STATE WATER RESOURCES COMMISSION
RECEIVED
JUL 29 1969
ANSWERED
RETURNED
FILED

August 1, 1969

Angus Park Woolen Co., Inc.
c/o William G. Park, President
Hanover, Connecticut 06350

Subject: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

Thank you for your letter of July 25, 1969, on the subject dam.

We agree that it would probably be easier to remove the trees in the winter and would be willing to go along with this suggestion. Also, it would be impractical to flatten the downstream slope with the trees in place, so this item could also be deferred until next Spring or Summer.

We have the recommendation of our consultant engineer " - - - that additional stability and safety, be achieved by flattening this (the downstream) slope". If your engineer agrees with this conclusion, we request that plans be prepared by an engineer registered in the State of Connecticut and bearing his certification and seal and submitted to this agency for approval for this work. If he disagrees, we request that he submit a report with his stability analysis to substantiate this conclusion.

The work can be scheduled in a logical manner to effect economies or to make it easier, but we see no reason to delay in the engineering report or plans which we have requested. It is requested that you notify us before cutting down the trees.

Please advise us at your earliest convenience as to when we may expect to receive a report or plans from your engineer.

Very truly yours,

William H. O'Brien
Civil Engineer

WHO:jad

cc: John Mozzochi
Photo copy sent to John Luchs 8/6/69
with note "Your file No. 57-73-50"

CHANDLER & PALMER
CIVIL ENGINEERS
114-116 THAYER BUILDING
TELEPHONE 887-3640

BENJAMIN H. PALMER
SHEPARD B. PALMER

DAMS
WATER SUPPLIES
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MEMBERS AMERICAN AND CONNECTICUT SOCIETIES
OF CIVIL ENGINEERS

NORWICH, CONN. 06360

RECEIVED
8/6/69

August 5, 1969

Angus Park Woolen Company
Hanover
Connecticut

Re: Hanover Reservoir Dam

Gentlemen:

Apparently the State is going to insist that we make a plan and take cross-sections on the Reservoir Dam.

I will do this just as soon as possible. However, I don't think it is anything critical and it will have to wait until we get some of our other work cleaned up. We will however do it as soon as possible.

Very truly yours,

B. H. Palmer

Chandler & Palmer

BHP:mds

ANGUS PARK WOOLEN CO., INC.

HANOVER, CONN. 06350

August 8, 1969

Mr. William H. O'Brien, Civil Engineer
State of Connecticut
Water Resources Commission
State Office Building
Hartford, Connecticut 06115

Re: Hanover Reservoir Dam

Dear Mr. O'Brien:

As suggested in your letter of August 1st we have contacted our engineers, Chandler & Palmer, of Norwich, Connecticut, and are sending you a photostat of the reply we have received from them.

We trust the matter is now well in hand and the solution satisfactory to you.

We have in mind to advise your office before the actual cutting of trees commences.

Very truly yours,

ANGUS PARK WOOLEN CO., INC.

William G. Park

WGP/ab

August 12, 1969

Mr. William G. Park, President
Angus Park Woolen Company
Hanover, Connecticut 06350

Re: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

Thank you for your letter of August 8, 1969, on the subject dam. We note that you intend to inform us before the trees are removed. This is requested so that we may identify the species if we feel it is necessary prior to cutting.

From the copy of the August 5, 1969 letter from B. H. Palmer, it appears that there may be a misunderstanding. We are not insisting that you prepare a plan. We are requesting that you have an engineer either send us a report with his conclusion that the dam is safe as it is, or plans to make it safe.

We hope to hear from you within the next month as to when your engineer will be able to meet these requests.

Very truly yours,

William H. O'Brien, III
Civil Engineer

WHOIII/tvm

cc: John Lechs
Benjamin H. Palmer

January 21, 1970

Mr. William G. Park
President
Angus Park Woolen Company
Hanover, Connecticut 06350

Subject: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

Would you please advise us as to when we may expect to receive a report from your engineer as to the safety of the subject dam?

Very truly yours,

William H. O'Brien, III
Civil Engineer

WHO:IIIcmk

April 9, 1970

Mr. William G. Park
President, Angus-Park Woolen Company
Hanover, Connecticut 06350

RE: Hanover Reservoir Dam
Sprague

Dear Mr. Park:

We have repeatedly requested that you have an engineer submit a report on his opinions as to the safety of the subject dam. We have a consulting engineer's report in our files which states that the downstream slope of the dam should be flattened to increase its stability.

We request that you notify this office in writing prior to April 30, 1970 as to when we may expect to receive such a report we trust that more formal action will not be required.

We will plan to have a field conference at the dam in late spring to determine the best way of handling the problem of trees growing on the downstream slope.

Very truly yours,

William H. O'Brien III
Civil Engineer

WHO/lch

ANGUS PARK WOOLEN CO., INC.

HANOVER, CONN. 06350

May 6, 1970

William H. O'Brien III
Civil Engineer
State of Connecticut
Water Resources Commission
State Office Building
Hartford, Connecticut 06115

Ref: Hanover Reservoir Dam,
Sprague

Dear Mr. O'Brien:

This is in acknowledgment of your letter of April 9th addressed to Mr. William G. Park. Since early Fall last year Mr. Park has undergone a period of extremely ill health during which time he has been fully incapacitated as far as business activity is concerned and has only been back on a very limited basis since the end of April.

Your letter was brought to my attention quite recently and in the meanwhile I have endeavored to familiarize myself with the subject by perusing the lengthy correspondence which has ensued between your office and ours since 1963, but most of which takes place during the year, 1969.

It is evident we have been remiss in not carrying out certain things which we have stated would be done. There have, however, been certain extenuating circumstances. Foremost among these is the fact that during the freeze period of last Winter certain emergencies occurred in our manufacturing facility which prevented our own Maintenance Department from removing the trees on the pond slope of the dam as well as on the landward slope.

Your most recent letter suggests a field conference will be held at the dam in the near future to determine the best way of handling the problem of the trees on the downstream slope. Our own engineers, Chandler & Palmer, have confirmed that they feel these trees should be removed for fear that otherwise the possibility of uprooting in the face of a severe windstorm would substantially weaken the dam and cause a dangerous condition. Although the writer does not pretend to be an engineer, it is his belief that some of the growth should remain, such as sapplings and perhaps trees measuring

not more than 12" at the base; thus enabling some growth to remain on the downstream slope with a view of preventing erosion on the slope which otherwise might be caused by sudden and heavy rainfall.

Our engineers also evidently agree that a certain amount of filling and grading over the steep portion of the slope is desirable in the interest of strengthening this portion of the dike. At the moment we have no idea just how much would be involved here from the standpoint of total dollars expenditure. Naturally it is not the attitude of this Company not to do its part to rectify what may be an unsafe condition, but we are not in a position to embark on a grandiose project which might be more elaborate than actual safety requires.

We would further suggest that the trees on the pond slope of the dam, which is a short slope averaging four to eight feet above normal water level, be removed at the next time of heavy freeze-over. The tree growth here consists mostly of small trees and birch sapplings with the larger trees growing almost at road level.

We regret the delay in answering your letter of April 9th and the apparent negligence on our part in taking action on this situation.

Yours very truly,

ANGUS PARK WOOLEN CO., INC.

Angus W. Park,
President

COPY

STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

STATE OFFICE BUILDING • HARTFORD, CONNECTICUT 06115

COPY

17 October 1974

March Engineers
[illegible] Elliott Street
Hartford, CT 061[illegible]5

Re: Hanover Reservoir Dam
Sprague

Gentlemen:

Under the terms of your contract to act as a consultant to [illegible] department, will you please inspect and submit a report on [illegible] safety of the subject dam.

The dam is located on the Little River in the northern portion of the Town of Sprague.

Very truly yours,

Victor F. Galgowski
Supt. of Dam Maintenance
Water & Related Resources
Telephone no. 566-728[illegible]

MACCHI ENGINEERS

EXECUTIVE OFFICES • 44 GILLETT STREET • HARTFORD, CONN., 06105 • PHONE (203) 549-6190

A. J. MACCHI, P.E.
JOSE H. COSIO, P.E.
MICHAEL GIRARD, P.E.

ASSOCIATE CONSULTANT
PROF. C. W. DUNHAM

October 22, 1974

Mr. Victor Galgowsky
Supt. of Dam Maintenance
Water & Related Resources
Dept. of Environmental Protection
165 Capitol Avenue
Hartford, Conn. 06115

Re: Hanover Reservoir Dam
Sprague, Conn.

Dear Mr. Galgowsky:

Enclosed is our report on the inspection of the above-referenced dam in accordance with the request made in your letter of October 17, 1974.

Very truly yours,

MACCHI ENGINEERS

Jose H. Cosio

JOSE H. COSIO, P.E.

Encl.

HANOVER RESERVOIR DAM

SPRAGUE, CONNECTICUT

On October 18, 1974 J. H. Cosio, P.E. and R. Novotny of Macchi Engineers inspected the dam of the Hanover Reservoir. Following are our findings:

LOCATION

The reservoir is located in the Little River Valley just north of Hanover in the Town of Sprague, Connecticut. This reservoir is owned by the Angus Park Woolen Co., a textile mill which has closed within the last six months. Portions of the Town of Hanover still are supplied with water provenient from the Hanover Reservoir.

DESCRIPTION OF STRUCTURES

The dam is an earth and rock structure 521 feet long, reaching a height of about 30 ft. at the deepest channel section. The width of the top of the dam varies between 26 ft. and 45 ft. A 15 ft. wide paved town road runs along the top of the dam. The upstream embankment of the dam has a fairly uniform slope of about 2:1. The downstream slope varies considerably from Section to Section from about 2:1 to sections probably approaching 1:1 slopes or steeper. Some garbage and debris are accumulated in the downstream slope of the dam. In addition to the earth dam, at the east end there is a 152 ft. long stone masonry spillway bridged over by a 16 ft. wide bridge founded on two abutments and two piers. (See attached sketches.)

The earth-rock dam section does not show evidence of leaks. In a couple of low areas next to the downstream toe of the embankment there was ponded water on the day of the inspection, but, it seemed to be only runoff accumulation.

The spillway has a generous structural cross section and is in very good structural condition. The clear waterway opening is in the order of 136 ft. wide by 8 to 9 ft. high.

At the west end of the dam there is a gate that controls the water intake to a 54" diam. steel pipe serving the mills and, as stated before, supplying water into some areas of Hanover. The gate and the steel pipe are in good condition and in accordance with Mr. Parker, the gate functions properly.

The only area of relative concern is the substructure supporting the highway bridge over the spillway.

The East abutment of the bridge is badly deteriorated at the top to the extreme that about 1/3 of the area of the bearing plate of the north girder does not rest on the concrete. The low area of the abutment below the water line is in good condition.

The East pier of the bridge is badly scoured below the water line. The top shows slight deterioration.

The West pier and West abutments are in good condition. The bridge itself is a three span steel girder structure 153 ft. long, built probably within the last 30 years and recently painted.

Along the paved road that runs over the dam there are no visible signs of horizontal displacements or settlements.

HYDRAULIC CONSIDERATIONS

The total drainage area for this structure is 32.1 sq. mi. Within this area there are large storage (swamp) areas. The contributing area is a long narrow valley. Fourteen miles upstream of the Hanover Reservoir is located the Hampton Reservoir on the same valley. There is a gaging station in Little River which was established in 1951, located only 1.7 miles north of the Hanover Reservoir. The following information was obtained from the U.S. Geological Survey Office with regard to this gaging station:

Drainage area 29.1 sq. mi.

Long Term Mean Annual Flood 700 c.f.s.

Max. Recorded Flood (August 19, 1955) 1,400 c.f.s.

The U.S. Geological Service has also records at the Versailles Pond Dam located 4.2 miles downstream of the Hanover Reservoir, on the same valley. The following information was obtained from these records:

Drainage area 41.3 sq. mi.

Mean Annual Flood: 1,000 c.f.s.

Max. Recorded Flood (Sept. 21, 1938) 2,800 c.f.s.

Our hydraulic computations for the Hanover Reservoir give the following information:

Drainage area 32.1 sq. mi.

Mean Annual Flood 900 c.f.s.

100 Year Flood Frequency (5 MAF) = 4,500 c.f.s.

Spillway Capacity $Q = CxLxH^{3/2}$

$Q = 3 \times 136 \times 7^{3/2} = 7,550$ c.f.s.

Water depth of spillway to pass the computed 100 year flood frequency = 5 ft. approx.

These results indicate that the spillway seems to have

enough capacity to accommodate a 100 year frequency flood.

Inquiries were made in the area about the dam ever being overtopped. Mr. Parker of the Agnus Park Woolen Co. stated that he has no such recollection. Mr. Maurice St. Germain, Baltic's Fire Chief, stated that in 1955 a small amount of water went over the top, but, traffic was kept on the road and no flooding occurred at the area. The U.S. Geological Survey Office indicated that they do not have records of the Hanover Reservoir to ascertain this matter. It was not possible to find anyone who could recollect the behavior of the dam during the 1938 flood.

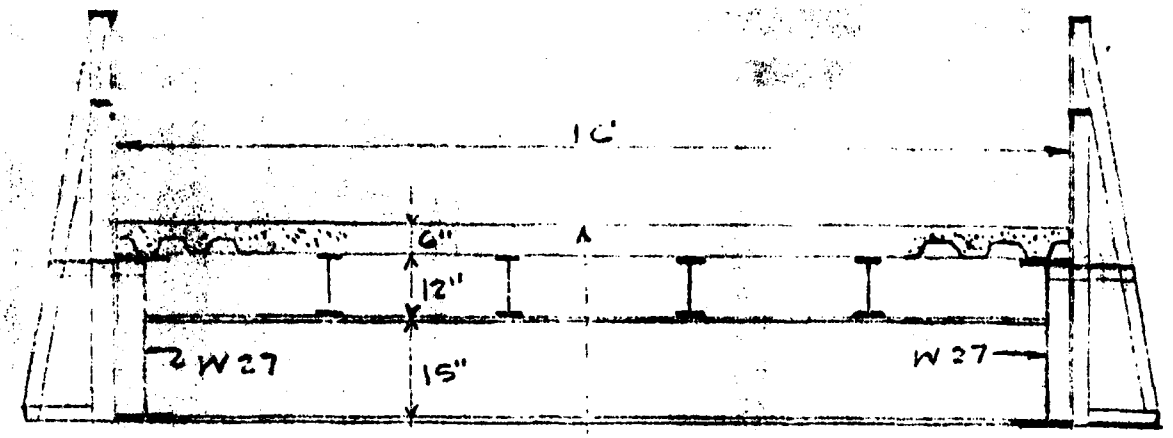
CONCLUSIONS

a) The dam in its present condition seems a safe and adequate structure.

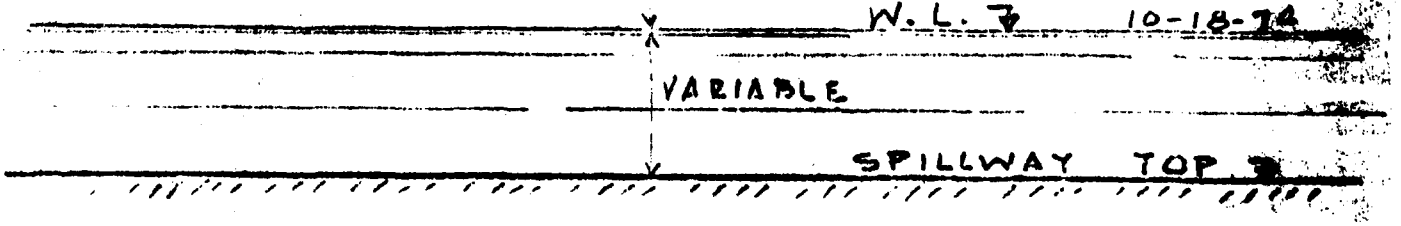
b) The East abutment and East Pier of the bridge built over the spillway require attention.

c) A failure of this dam, which seems a remote possibility, would cause havoc especially in the Town of Hanover and Baltic. On this account it may be prudent to make a further structural study of the dam to ascertain its stability at the sections where the downstream slope of the embankment is steeper than 1.5:1.

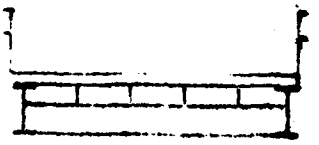
BY J.H.C. DATE 10-21-74 SUBJECT HANOVER RESERVOIR SHEET NO. 2 OF 2
CHKD. BY ____ DATE ____ SPRAGUE, CONN. JOB NO. ____

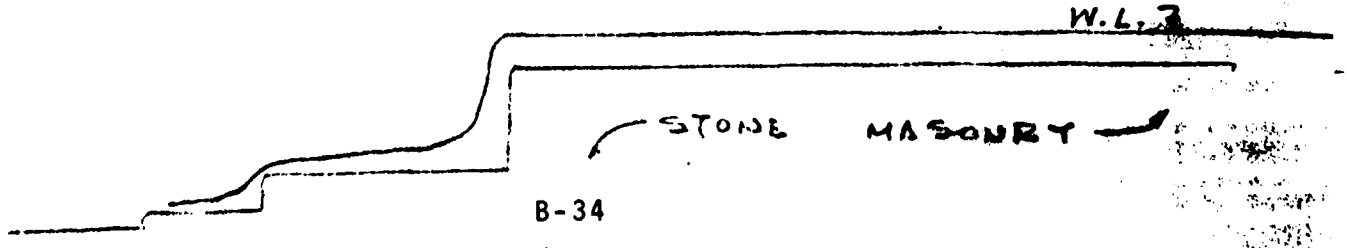


8.75' ON 10-18-74



BRIDGE SECTION
1" = 5'

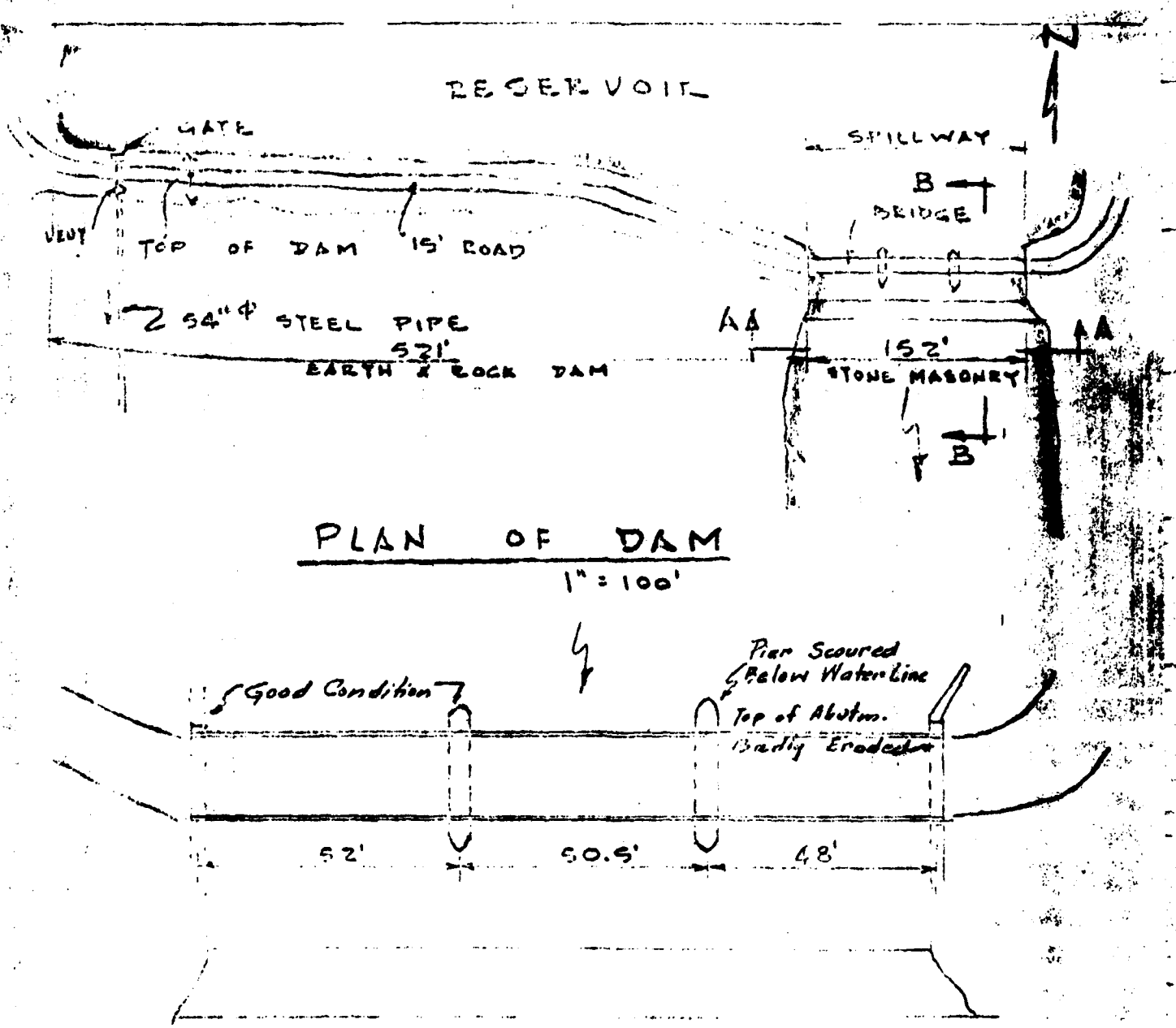




B-34

SPILLWAY SECTION B-B

BY J.H.C. DATE 10-21-74 SUBJECT HANOVER RESERVOIR SHEET NO. 1 OF
CHKD. BY DATE SPRAGUE, CONN. JOB NO.

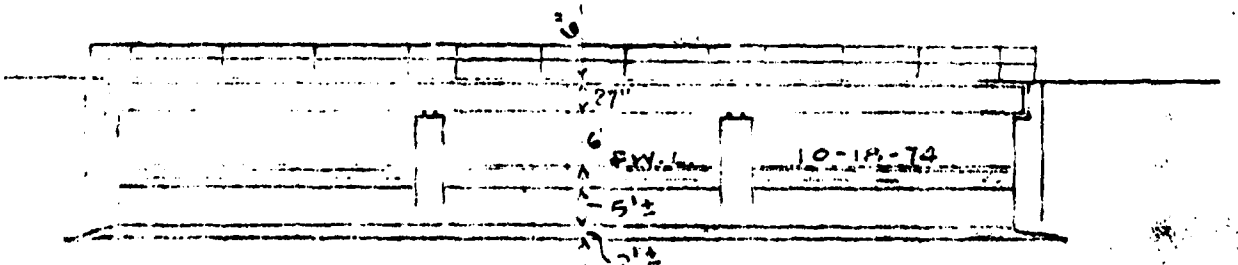


PLAN OF DAM

1" = 100'

PLAN OF BRIDGE

1" = 30'



SPILLWAY ELEVATION A-A

1" = 7'

Interdepartment Message

Victor F. Galgowski Water Resources Unit	Supt. of Dam Maintenance	17 January 1980
Charles J. Pelletier Environmental Protection	Consultant	

Sprague - Hanover Reservoir Dam

Some concern has been expressed about the effect of failure of this dam on the facilities of Federal Paper Board Co., which is located about two miles downstream and immediately downstream from Paper Mill Pond Dam. If Hanover Reservoir Dam failed at a time of ordinary runoff rate (no significant overbank flow along the downstream channel), it is unlikely that it would cause significant damage to Federal. Hanover Reservoir contains about 300 acre-feet of stored water. The area of floodplain, including the area of Papermill Pond, between Hanover Reservoir and Federal is about 185 acres. It is our feeling that the storage in this two mile reach of river would attenuate peak outflow rates to the extent that it would cause little of any damage to Federal.

A failure occurring during a large flood might result in a sudden stage increase sufficient to cause additional damage to Federal depending on the timing of the failure relative to timing of the flood wave on which it was superimposed. Further detailed analysis to establish with some precision the magnitude of the flood wave caused by a failure, can be provided if you wish. (This will probably be done by the Corps of Engineers if a Phase I study is done on Hanover Reservoir Dam.)

The Hanover Reservoir Dam was inspected on January 16, 1980. The condition is little changed from 1976, the time of the last inspection. Seepage flow appears to be about the same. Some large trees on the downstream side have died and several have been cut. There also has been some additional dumping of boulders, waste soil, brush and other debris on the downstream slope.

We do not feel that the dam is in imminent danger of collapse. However, to insure continued stability, we recommend that the practice of dumping on the slope to be discontinued and that the material already dumped be removed along with all trees. When clearing is completed, the area should be refilled with free draining material on a flatter slope with a toe drain to control seepage. It would also be appropriate to require of the owner detailed analysis of embankment stability, spillway capacity and freeboard.

Water Resources Unit

CJP:ljk

COPY

COPY

STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

[illegible] HARTFORD [illegible]

21 January 1980

Mr. Matthew T. Delaney
First Selectman
Box 162
Main Street
Baltic, CT 06330

Re: Hanover Reservoir Dam
Sprague

Dear Mr. Delaney:

Pursuant to our inspection on January 16, 1980, we do not feel the subject dam is in any imminent danger of failure. Conditions noted indicate very little change since our inspection in 1976. The seepage pattern appears to be about the same. Some additional dumping of boulders, waste soil, brush and other debris on the downstream slope has taken place.

From our observations of the area downstream of the dam we find the floodplain areas between the dam and Federal Paper Board Co. to equal approximately 185 acres. If the Hanover Dam failed at a time of ordinary runoff, it is unlikely that it would cause significant damage to the factory due to the storage provided by the floodplain. A failure occurring during a large flood might result in some damage. Further detailed analysis is required to establish the magnitude of the resulting flood wave.

The dam is scheduled for inspection by the Corps of Engineers this year. Upon receipt of the results of their inspection, we will request the owner of the dam to implement any recommendations for repairs or alterations listed. In the meantime, we suggest dumping of debris on the dam be prohibited and the dam be monitored during periods of heavy runoff.

Very truly yours,

Victor F. Galgowski
Supt. of Dam Maintenance
Water Resources Unit
Telephone no. 566-7245

VFG:ljk

cc: Mr. Ray Armstrong

APPENDIX C

DETAIL PHOTOGRAPHS

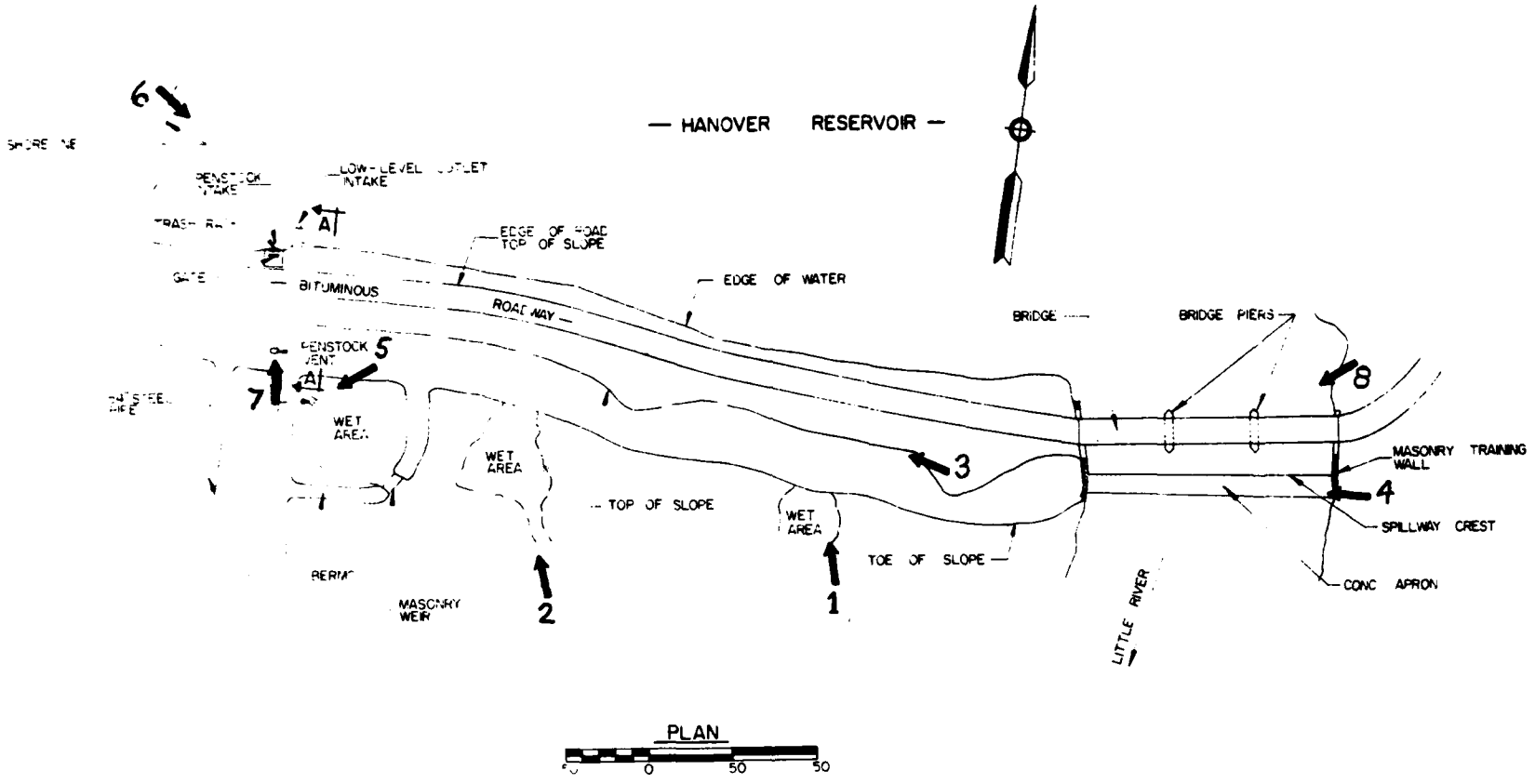


PHOTO LOCATION PLAN

HANOVER RESERVOIR DAM

SHEET C-1

Photo 1 - Seepage and wet area located approximately 160 feet right of the spillway (6/2/80).

Photo 2 - Flow in 6 foot wide swale away from center wet area (6/2/80).

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	Hanover Reservoir Dam Little River Sprague, Conn.
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE# 27 785 KB DATE July, '80 PAGE C-1

Photo 3 - Downstream slope of dam. Note steepness of slope, trees, and debris on slope (6/2/80).

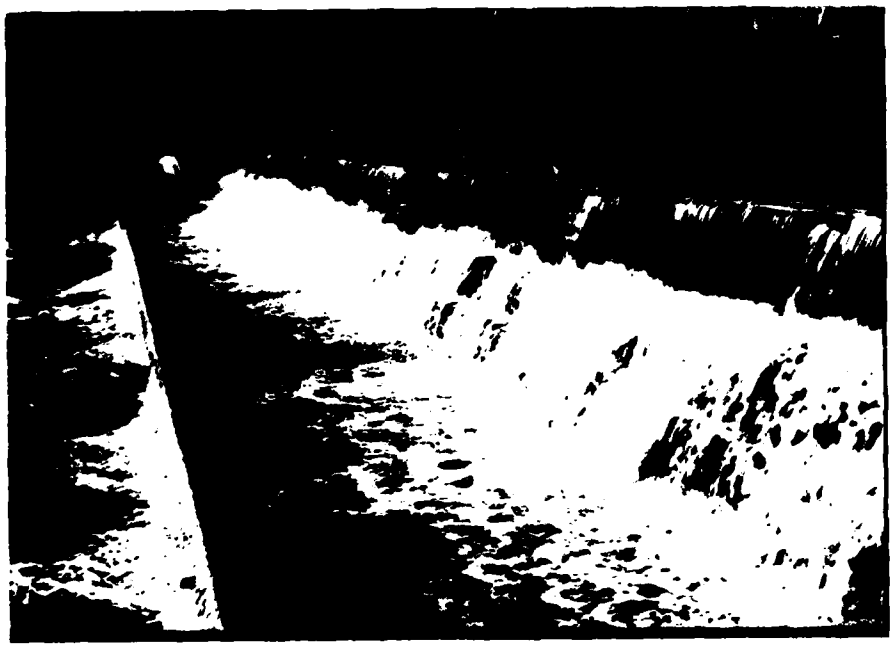


Photo 4 - Masonry spillway and concrete splash apron (6/2/80).

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS. CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	Hanover Reservoir Dam Little River Sprague, Conn. CE# 27 785 KB DATE July, '80 PAGE C-2

Photo 5 - 54 inch steel low-level outlet pipe. Note seepage flow in pipe (6/2/80).

Photo 6 - Low-level intake structure at left and penstock intake structure at right (6/2/80).

Photo 7 - Penstock "vent" on downstream slope of embankment (6/2/80).

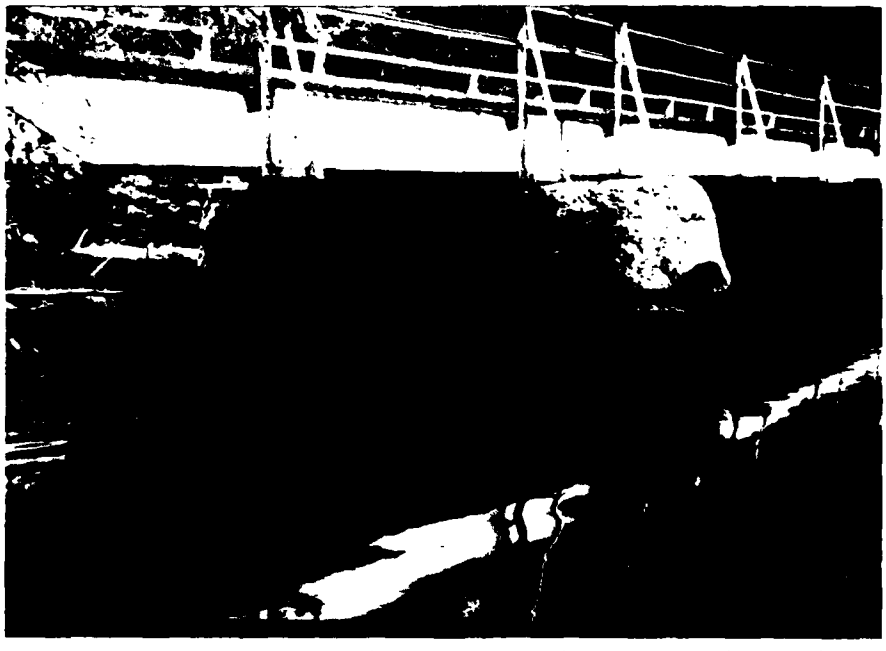
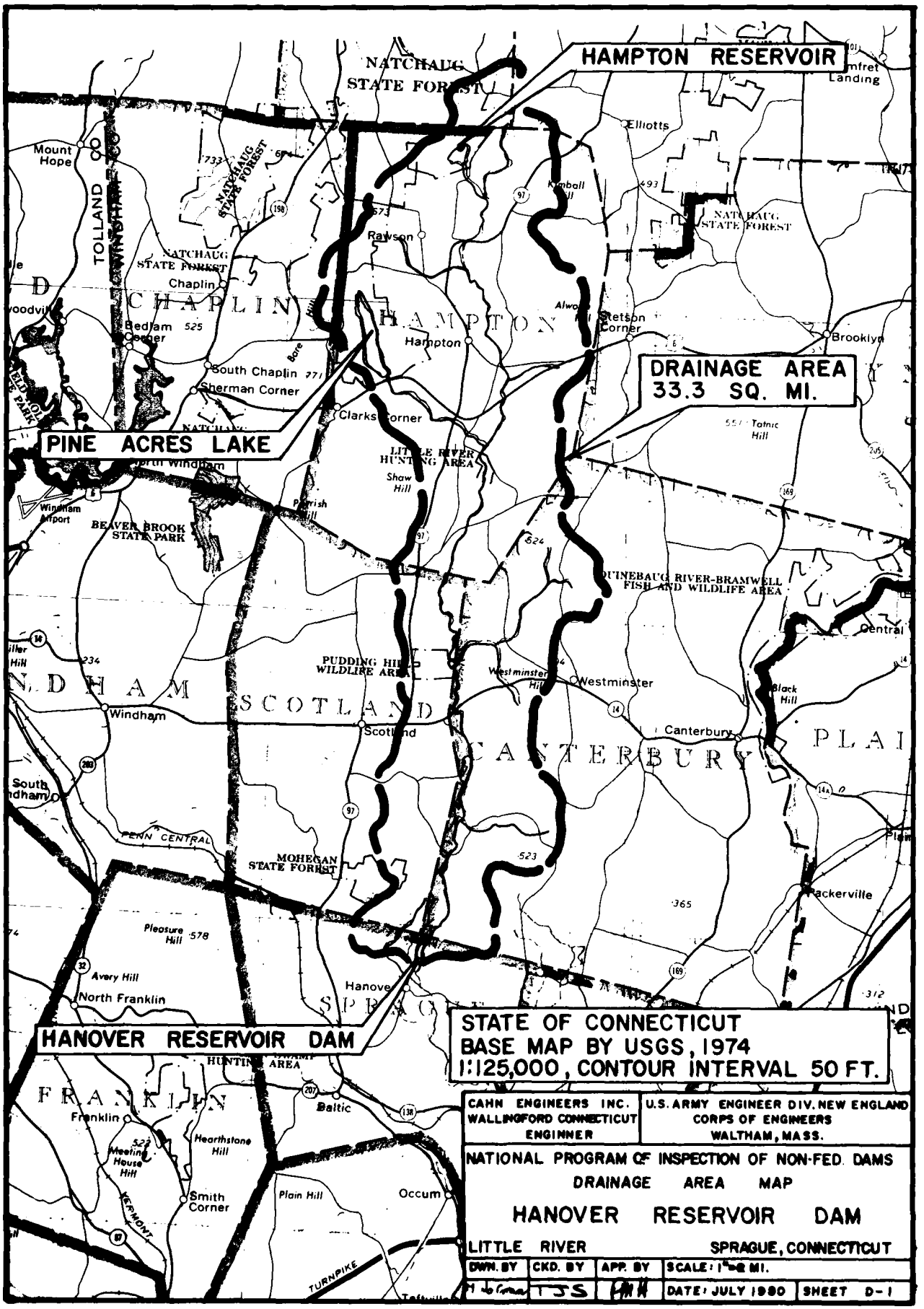
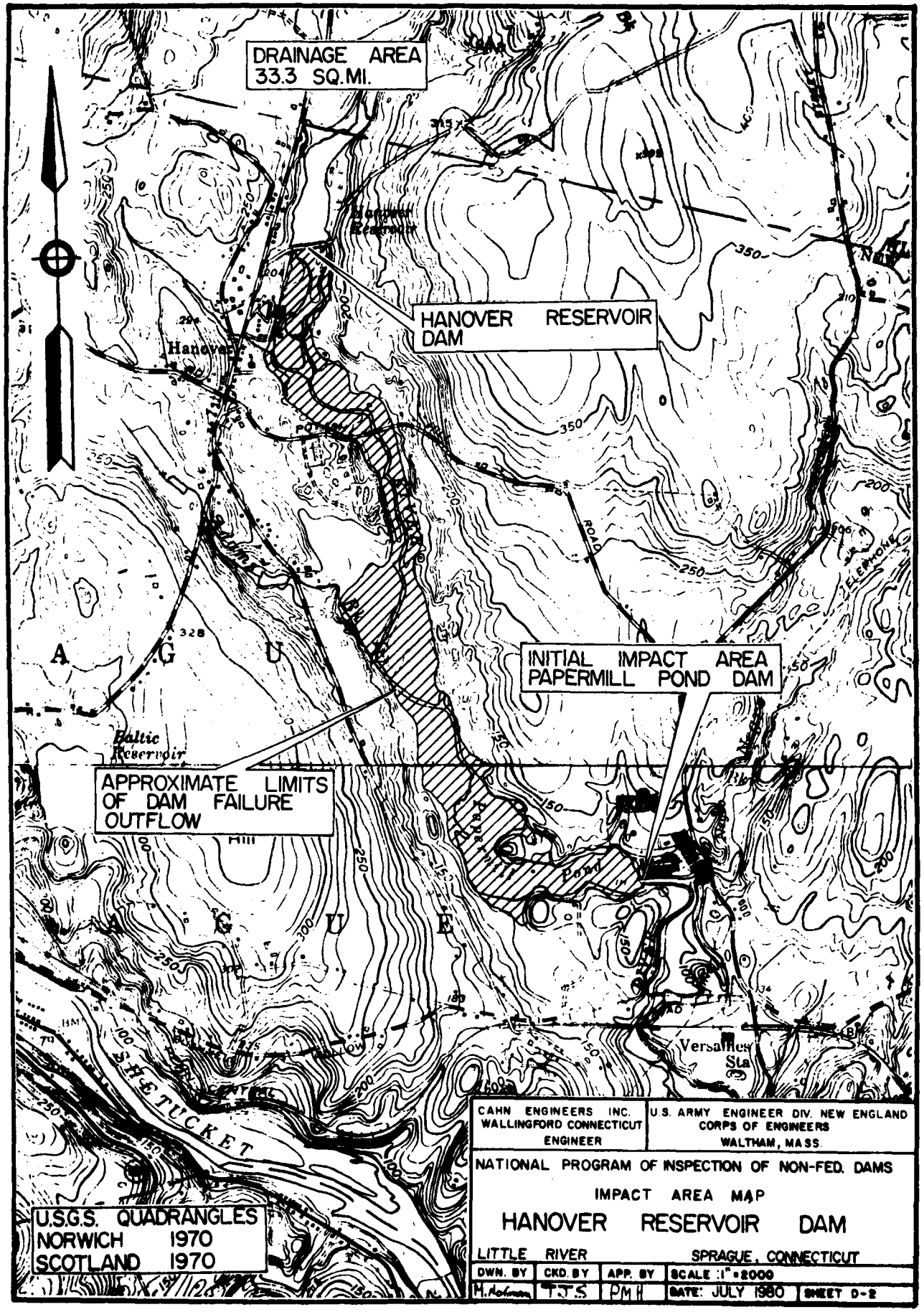


Photo 8 - Left bridge pier. Note erosion of concrete (6/2/80).

APPENDIX D

HYDRAULICS/HYDROLOGIC COMPUTATIONS


HAMPTON RESERVOIR
PINE ACRES LAKE
DRAINAGE AREA
33.3 SQ. MI.
HANOVER RESERVOIR DAM
NATCHAUG STATE FOREST
TOLLAND
CHAPLIN
HAMPTON
SCOTLAND
CANTERBURY
FRANKLIN
Mount Hope
Elliotts
Rawson
Chaplin
Bedlam Corner
South Chaplin
Sherman Corner
Hampton
Clarks Corner
Stetson Corner
Brooklyn
Tatnic Hill
Shaw Hill
Parrish Hill
Windham Airport
BEAVER BROOK STATE PARK
LITTLE RIVER HUNTING AREA
QUINEBAUG RIVER-BRAMWELL FISH AND WILDLIFE AREA
PUDDING HILL WILDLIFE AREA
Westminster
Central
Windham
Scotland
Canterbury
Black Hill
Packerville
South Windham
PENN CENTRAL
MOHEGAN STATE FOREST
Pleasure Hill
Avery Hill
North Franklin
Hanover
Baltic
Franklin
Hearthstone Hill
Meeting House Hill
Smith Corner
Plain Hill
Occum
VERMONT
TURNPIKE
STATE OF CONNECTICUT
BASE MAP BY USGS, 1974
1:125,000, CONTOUR INTERVAL 50 FT.
CAHN ENGINEERS INC.
WALLINGFORD CONNECTICUT
ENGINNER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
DRAINAGE AREA MAP
HANOVER RESERVOIR DAM
LITTLE RIVER
SPRAGUE, CONNECTICUT
DWN. BY
CKD. BY
TJS
APP. BY
SCALE: 1" = 2 MI.
DATE: JULY 1980
SHEET D-1



CAHN ENGINEERS INC. WALLINGFORD CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

IMPACT AREA MAP

HANOVER RESERVOIR DAM

LITTLE RIVER SPRAGUE, CONNECTICUT

DWN. BY	CKD. BY	APP. BY	SCALE :1" = 2000	
H. Hofmann	T.J.S.	PMH	DATE: JULY 1980	SHEET D-2

HYDROLOGIC/HYDRAULIC INSPECTION

HANOVER RESERVOIR DAM, SPRAGUE, CT.

I) PERFORMANCE AT PEAK FLOOD CONDITIONS

1) PROBABLE MAXIMUM FLOOD (PMF)

a) WATERSHED CLASSIFIED AS "FLAT" TO "ROLLING," MAINLY BECAUSE OF THE LARGE VALLEY STORAGE CAPACITY OF THE WATERSHED.

b) WATERSHED AREA: DA = 33.3 sq mi

NOTE: D.A. FROM CONN. DEP BULLETIN No. 1, 1972 (GAZETTEER OF HYDRAULIC DRAINAGE AREAS) p. 11.

c) PEAK FLOODS (FROM NED-ACE GUIDELINES - GUIDE CURVES FOR PMF)

i) FROM GUIDE CURVES: CSM = 650 cfs/sq mi

ii) PMF = 650 x 33.3 = 21600 cfs

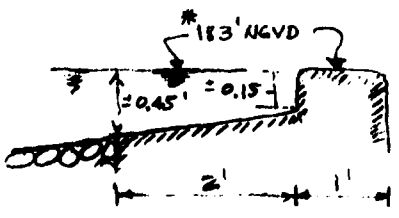
iii) ½ PMF = 10800 cfs

2) SURCHARGE AT PEAK INFLOWS (PMF AND ½ PMF)

a) OUTFLOW RATING CURVE:

i) SPILLWAY AND OVERFLOW PROFILE FOR SURCHARGES OVERTOPPING THE DAM:

SPILLWAY (±) 147' LONG, BROADCRESTED (SEE SKETCH). ROAD ON EMBANKMENT CROSSING SPILLWAY APPROACH CHANNEL (℄ (±) 27' U/S FROM SPILLWAY CREST) ON BRIDGE WITH 2 INTERMEDIATE PIERS (℄ ≈ 26'; b ≈ 5'). LOW CHORD (±) 6.5' ABOVE SPILLWAY CREST; BRIDGE DECK + BEAMS (±) 33" THICK. THE BRIDGE DECK IS (±) 16' WIDE.

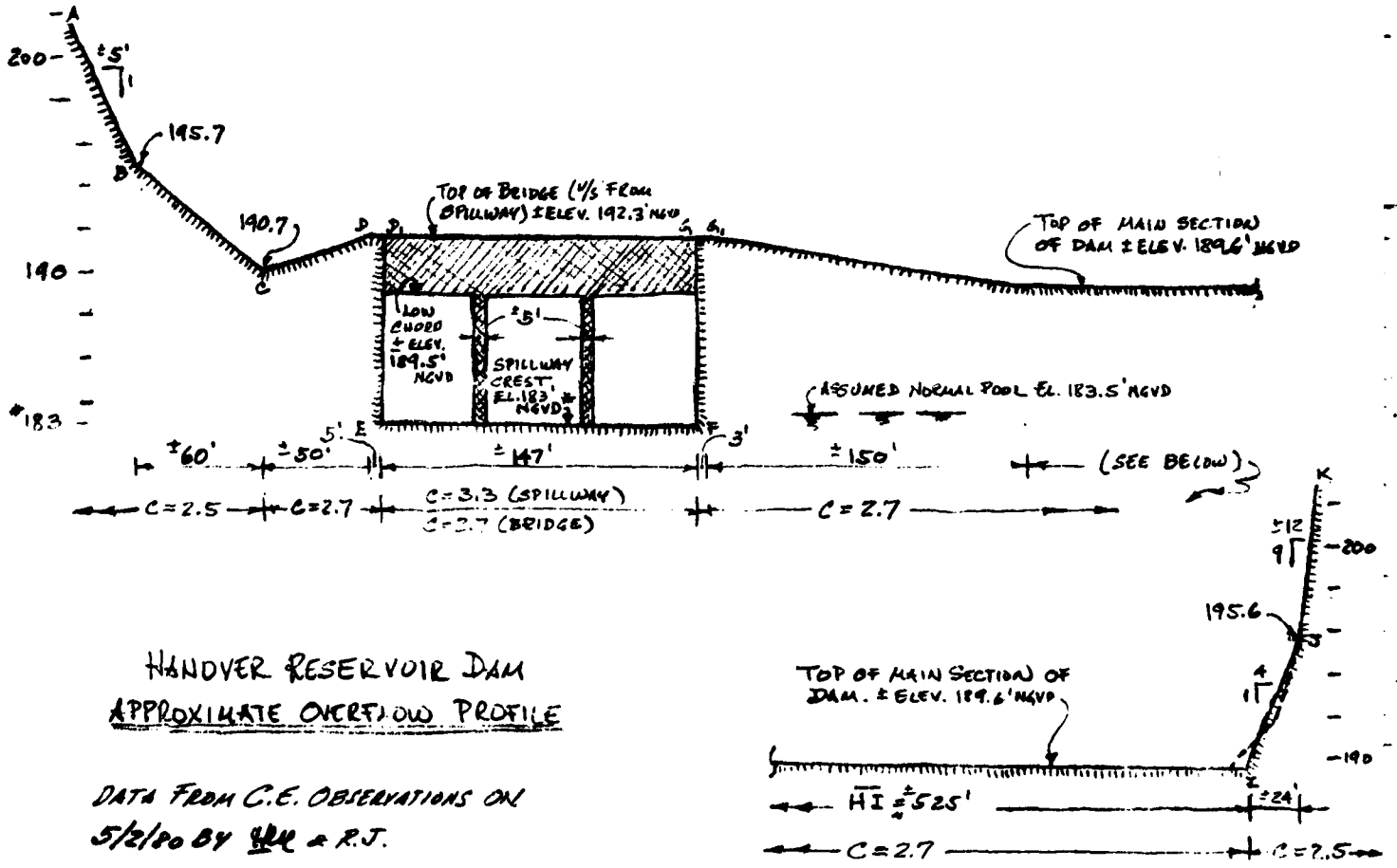


SPILLWAY CREST SKETCH.

*SEE NOTE ON P. D-2

THE OVERFLOW SECTION IS FORMED MAINLY TO THE RIGHT OF THE SPILLWAY BY THE PAVED TOP OF THE EMBANKMENT AND EXTENDS AT BOTH SIDES ON THE ADJACENT WOODED TERRAIN. BOTH SLOPES OF THE DAM EMBANKMENT HAVE TREES AND UNDERBRUSH.

THEREFORE, ASSUME C=3.3 FOR THE SPILLWAY FLOW; C=2.7 FOR THE DAM (ROAD) AND C=2.5 FOR THE ADJACENT TERRAIN OVERFLOWS. LOSS THRU THE BRIDGE WILL BE COMPUTED AS WEIR (C=2.7) AND ORIFICE FLOW (C_D=0.82) (SEE OVERFLOW PROFICE).



HANOVER RESERVOIR DAM
APPROXIMATE OVERFLOW PROFILE

DATA FROM C.E. OBSERVATIONS ON 5/2/80 BY [illegible] & R.J.

*NOTE: W.S. ELEV. 183' M.S.L. ON THE USGS SCOTLAND, CT. QUADRANGLE SHEET (1953) IS ASSUMED TO BE SPILLWAY CREST ELEVATION IN NATIONAL GEODETIC VERTICAL DATUM (NGVD)

ii) THEREFORE, ASSUMING EQUIVACENT RATINGS FOR THE SLOPING TERRAIN, THE OVERFLOW RATING CURVE FOR THE SURCHARGE (H_1) ABOVE THE SPILLWAY CREST CAN BE APPROXIMATED AS FOLLOWS (SEE PROFILE p.D-2):

1') SECTION AB: $Q_{AB} = \frac{2}{3} \times 5 \times 2.5 (H_1 - 12.7)^{5/2} \simeq \underline{8.33 (H_1 - 12.7)^{5/2}}$

2') SECTION BC: $(Q_{BC})_1 = \frac{2}{3} \times 12 \times 2.5 (H_1 - 7.7)^{5/2} = \underline{20 (H_1 - 7.7)^{5/2}}$; $H_1 \leq 12.7$

$(Q_{BC})_2 = 60 \times 2.5 (H_1 - 8.88)^{3/2} \simeq \underline{150 (H_1 - 8.88)^{3/2}}$; $H_1 > 12.7$

3') SECTION CD: $(Q_{CD})_1 = \frac{2}{3} \times 50/1.6 \times 2.7 (H_1 - 7.7)^{5/2} \simeq \underline{56.3 (H_1 - 7.7)^{5/2}}$; $H_1 \leq 9.3$

$(Q_{CD})_2 = 50 \times 2.7 (H_1 - 8.08)^{3/2} \simeq \underline{135 (H_1 - 8.08)^{3/2}}$; $H_1 > 9.3$

4') SECTION DG$_1$ (BRIDGE OVERTOP):

$Q_{DG_1} = 2.7 \times 155 (H_1 - 9.3)^{3/2} \simeq \underline{419 (H_1 - 9.3)^{3/2}}$

5') SECTION D$_1$G (BRIDGE UNDERFLOW):

$Q_{D_1G} \simeq 0.82 \times 137 \times H_x \sqrt{2g (\Delta H)} \simeq \underline{902 H_x (\Delta H)^{1/2}}$

$H_x \simeq H$ FOR $H \leq 6.5'$; $H_x = 6.5'$ FOR $H > 6.5'$

(4',5') SPILLWAY (SECTION EF):

$Q_S = Q_{EF} = 3.3 \times 147 H^{3/2} = \underline{485 H^{3/2}}$ $(H_1 = H + \Delta H)$

NOTE: (ΔH) = LOSS THRU BRIDGE, IS DETERMINED BY ASSUMING SPILLWAY FLOW EQUAL TO THE BRIDGE FLOW (EQS 4' & 5') AND $H_1 = H + \Delta H$ FOR ANY SURCHARGE.

6') SECTION G$_1$H: $(Q_{G_1H})_1 = \frac{2}{3} \times 150/2.7 \times 2.7 (H_1 - 6.6)^{5/2} \simeq \underline{100 (H_1 - 6.6)^{5/2}}$; $H_1 \leq 9.3$

$(Q_{G_1H})_2 = 150 \times 2.7 (H_1 - 7.24)^{3/2} \simeq \underline{405 (H_1 - 7.24)^{3/2}}$; $H_1 > 9.3$

7') SECTION HI: $Q_{HI} = 525 \times 2.7 (H_1 - 6.6)^{3/2} = \underline{1420 (H_1 - 6.6)^{3/2}}$

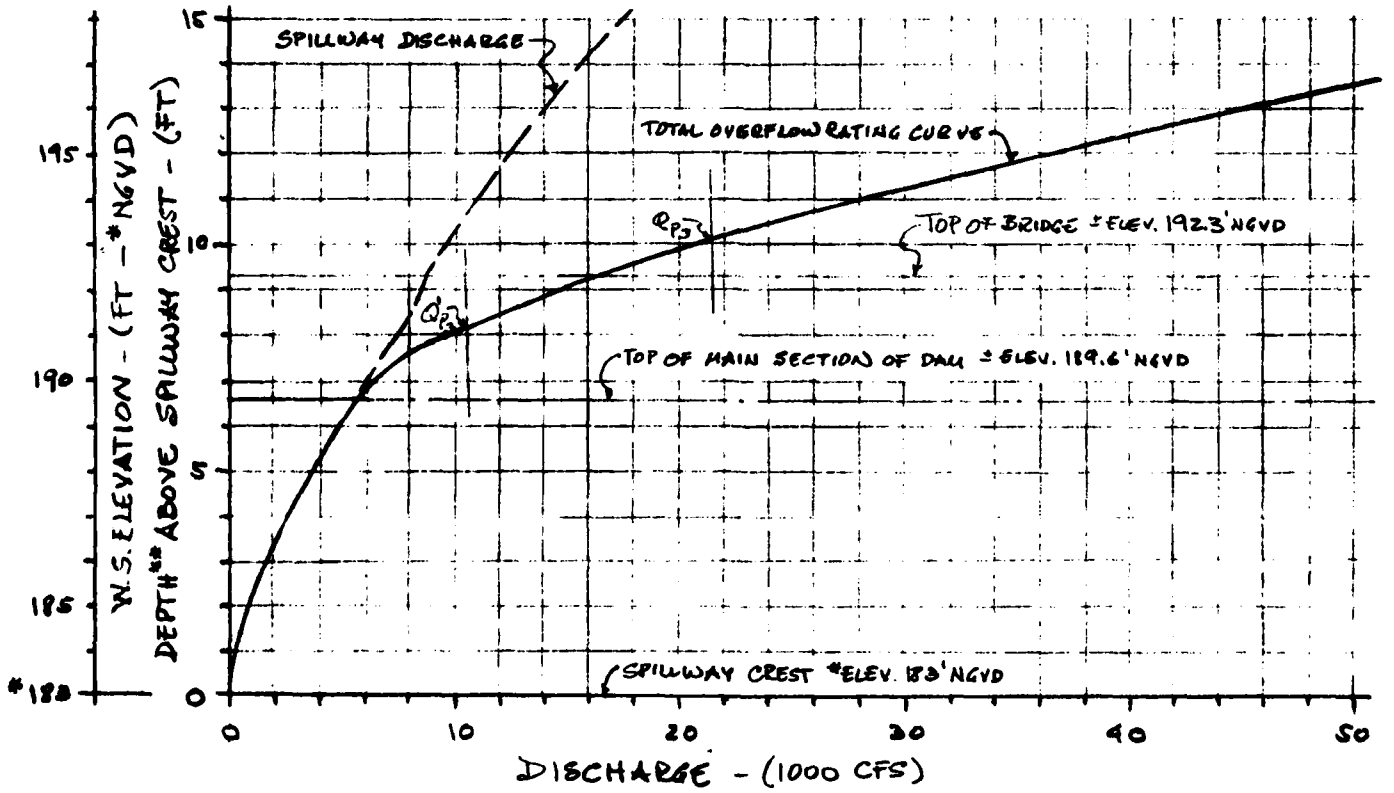
8') SECTION JJ: $(Q_{JJ})_1 = \frac{2}{3} \times 4 \times 2.5 (H_1 - 6.6)^{5/2} = \underline{6.67 (H_1 - 6.6)^{5/2}}$; $H_1 \leq 12.6$

$(Q_{JJ})_2 = 24 \times 2.5 (H_1 - 8.02)^{3/2} = \underline{60 (H_1 - 8.02)^{3/2}}$; $H_1 > 12.6$

9') SECTION JK: $Q_{JK} = \frac{2}{3} \times \frac{12}{9} \times 2.5 (H_1 - 12.6)^{5/2} = \underline{2.22 (H_1 - 12.6)^{5/2}}$

THEREFORE, THE TOTAL OUTFLOW IS APPROXIMATED BY THE COMBINATION OF ALL THE APPLICABLE FORMULAE ON ITEMS (1') TO (9')

iii) HANOVER RESERVOIR DAM - OUTFLOW RATING CURVE



*SEE NOTE p. D-2

** DEPTH (SURCHARGE) $^4/_5$ FROM BRIDGE

b) SURCHARGE HEIGHT TO PASS PEAK INFLOWS ($Q_{I_1} \& Q'_{I_1}$)

i) @ Q_{I_1} = PMF ≅ 21600 CFS $H_1 \cong \underline{10.0'}$

ii) @ Q'_{I_1} = ½ PMF ≅ 10800 CFS $H'_1 \cong \underline{8.2'}$

c) EFFECT OF SURCHARGE STORAGE - PEAK OUTFLOWS:

i) AVE LAKE AREA ($\bar{A}$) WITHIN EXPECTED SURCHARGE:

1') LAKE AREA AT FLOW LINE (EL. 183' NGVD)*: $A_{WL} = 16.5^{AC}$
2') AREA AT CONTOUR 190' NGVD (MSC)*: $A_{190} = 34.1^{AC}$
3') AREA AT CONTOUR 200' NGVD (MSC)*: $A_{200} = 55.6^{AC}$

∴ AVE. AREA WITHIN EXPECTED SURCHARGE (±10'): $\bar{A} \cong \underline{26^{AC}}$
(LINEAR INTERPOLATION = $A_{187.5}$ – SEE CURVE p. D-6)

*NOTE: AREAS FROM USGS, SCOTLAND, CT. QUAD. SHEET (1953) - SCALE 1" = 2000'

ii) ASSUME NORMAL POOL AT ELEV. 183.5' NGVD ($H_1 = 0.5'$)

iii) WATERSHED D.A. ≅ 33.3 Sq mi (SEE p. D-1)

iv) PEAK OUTFLOWS ($Q_{I_3} \& Q'_{I_3}$)

(DETERMINED ON THE OUTFLOW RATING CURVE (p. D-4), BY USING THE APPROX. ROUTING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING" ALTERNATE METHOD AND 19" MAX. PROBABLE P.O. IN NEW ENGLAND).

$Q_{I_3} = 21400$ CFS $H_3 \cong \underline{10.0'}$

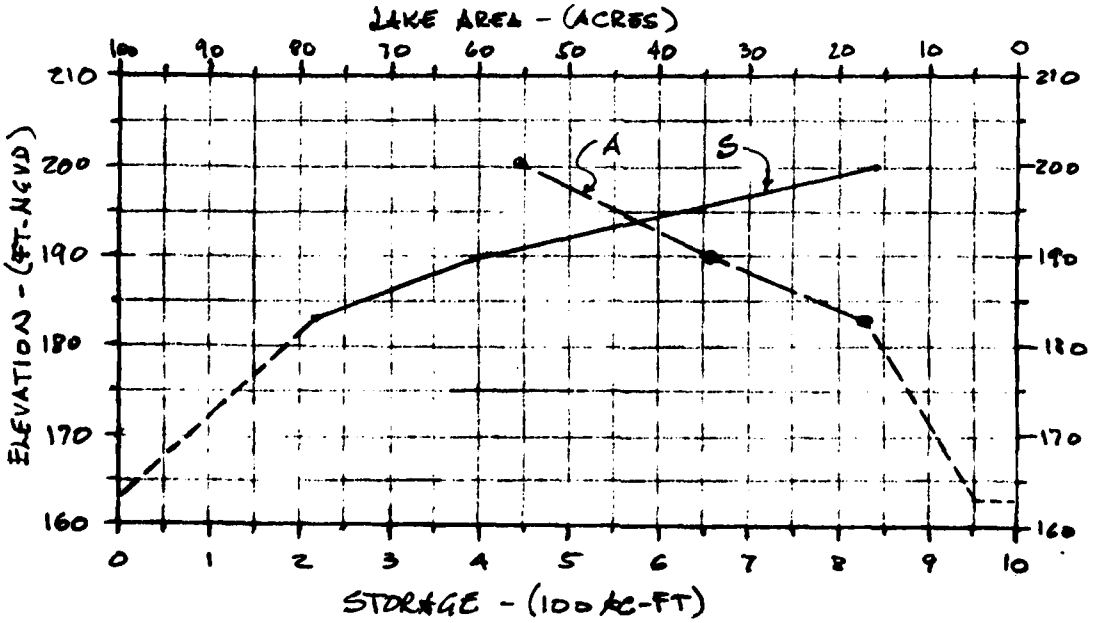
$Q'_{I_3} = 10700$ CFS $H'_3 \cong \underline{8.1'}$

3) SPILLWAY CAPACITY RATIO TO PEAK OUTFLOWS:

SPILLWAY CAPACITY TO:	SURCH.* H_1 (FT)	W.S. ELEV. (FT-NGVD)	SPILLWAY CAPACITY (CFS)	SPILLWAY CAPACITY AS % OF PEAK OUTFLOWS	
				Q_{P3} (21400 CFS)	Q'_{P3} (10700 CFS)
TOP OF DAM**	6.6	189.6	5600	26	52
½ PMF	8.1	191.1	7600	—	71
PMF	10.0	193.0	9700	45	—

*SURCHARGE ABOVE SPILLWAY CREST (⅛ FROM BRIDGE)
**TOP OF MAIN SECTION OF DAM, ELEV. 189.6 NGVD

4) RESERVOIR AREA/STORAGE CURVES - HANOVER RESERVOIR



@AREAS MEASURED ON USGS - SCOTLAND, CT. QUADRANGLE SHEET (1953)
NOTE - SEE PP. D-5 (AREAS) AND D-8 (STORAGE)

HANOVER RESERVOIR DAM

II) DOWNSTREAM FAILURE HAZARD.

1) POTENTIAL IMPACT AREA:

NO PERMANENT RESIDENTIAL STRUCTURES (ACCESSIBLE TO THE INSPECTION PARTY) WERE FOUND ALONG LITTLE RIVER BETWEEN THE HANOVER RESERVOIR DAM AND PAPER MILL POND (±2 MI D/S). THEREFORE, OTHER THAN THE POSSIBLE ECONOMIC LOSS THAT THE FLOOD MAY CAUSE IN THIS REACH UPON FAILURE OF THE HANOVER RESERVOIR DAM. (A ROAD BRIDGE AND FARM LAND), THE POTENTIAL IMPACT AREA IS PROBABLY, THE INDUSTRIAL AND THE FEW RESIDENTIAL STRUCTURES WHICH ARE LOCATED ALONG LITTLE RIVER D/S FROM PAPER MILL POND (SEE ACE PHASE I INSPECTION REPORT FOR PAPER MILL POND DAM, CT00471, DATED DECEMBER 1979) AND VERSAILLES POND DAM.

2) FAILURE AT HANOVER RESERVOIR DAM

ASSUME SURCHARGE TO TOP OF DAM, ELEV. 189.6' NGVD

a) HEIGHT OF DAM*: $H \cong 26.5'$

b) MID-HEIGHT LENGTH*: $L \cong 740'$

c) BREACH WIDTH (SEE NED-ACE D/S DAM FAILURE GUIDELINES)

$W = 0.4 \times 740 = 296'$ ∴ ASSUME $W_b = \underline{290'}$

d) ASSUMED WATER DEPTH AT TIME OF FAILURE: $Y_o = \underline{26.5'}$

e) SPILLWAY DISCHARGE AT TIME OF FAILURE: $Q_s = 5600^{cfs}$ (SEE P. D-6)

*FROM CE. FIELD MEASUREMENTS ON 5/2/80 BY WM & R.S.

f) BREACH OUTFLOW (SEE NED-ACE GUIDELINES)

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, y_o^{3/2} = \underline{66500}^{cfs}$$

g) PEAK FAILURE OUTFLOW (Q_{p_1}) TO LITTLE RIVER:

$$Q_{p_1} = Q_s + Q_j \cong 72100^{cfs} \quad \text{SAY, } Q_{p_1} = \underline{72000}^{cfs}$$

3) FLOOD DEPTH* IMMEDIATELY D/S FROM DAM

$$y \cong 0.44\, y_o = \underline{11.7'}$$

*(FROM THE RETREATING WAVE THEORY APPLIED TO DAM FAILURE)

4) ESTIMATE OF D/S FAILURE CONDITIONS AT POTENTIAL IMPACT AREA:

(SEE NED-ACE GUIDELINES FOR ESTIMATING D/S FAILURE HYDROGRAPHS)

a) THE (±)10000' LONG REACH OF LITTLE RIVER FROM HANOVER RES. DAM TO PAPER MILL POND IS GENERALLY TRAPEZOIDAL IN CROSS SECTION WITH (±) 600' BASE AND (±) 10# AND 20# TO 1V SIDE SLOPES. THE AVERAGE REACH SLOPE IS (±) 0.62%. (ASSUME $n \cong 0.050$ AT FLOOD STAGE)

DATA ON PAPER MILL POND (SPILLWAY CAPACITY AND SURCHARGE STORAGE) AND ON THE LITTLE RIVER CHANNEL D/S FROM THIS DAM ARE GIVEN IN THE ACE PHASE I INSPECTION REPORT FOR PAPER MILL POND DAM, CT 00471, DATED DEC. 1979.

b) RESERVOIR STORAGE AT TIME OF FAILURE

$$^{*}S_{MAX} \cong 400^{AC\text{-}FT} \qquad S/2 \cong 200^{AC\text{-}FT}$$

* C.E. ESTIMATE BASED ON AN AVG. DEPTH OF (±) 13': $S_{NL} \cong 215^{AC\text{-}FT}$ AND SURCH. STORAGE TO TOP OF DAM ($S \cong 170^{AC\text{-}FT}$) $\therefore S \cong 385$; SAY, $S_{MAX} \cong 400^{AC\text{-}FT}$. ALSO, ACE, US. INVENTORY OF DAMS p 47, 1/23/80 GIVES $S_{MAX} \cong 200^{AC\text{-}FT}$. (SEE p. D-6)

c) APPROXIMATE STAGE D/S FROM DAM AFTER FAILURE:

i) CHANNEL REACH BETWEEN HANOVER RES. DAM AND PAPER MILL POND:

(THE REACH IS SUBDIVIDED TO HAVE $V_2 \leq V_1/2$; SEE NED-ACE GUIDELINES)

REACH L (FT)	Q_{P_1} (CFS)	Y_1 (FT)	V_1 (FPS)	Q_{P_2} (CFS)	Y_2 (FT)	V_2 (FPS)	$\bar{V}$ (FPS)	Q_{P_3} (CFS)	Y_3 (FT)
1150	72000	10	198	36400	6.8	125	162	42800	7.4
1650	42800	7.4	200	21400	5.0	127	164	25300	5.5
2300	25300	5.5	198	12800	3.7	127	163	15000	4.0
3200	15000	4.0	196	7650	2.7	128	162	8900	3.0
1700	8900	3.0	75	7200	2.6	66	70	7300	2.6

∴ PEAK FLOOD ENTERING PAPER MILL POND: $(Q_{P_1})_2 \simeq (Q_{P_3})_1 \simeq 7300^{CFS}$ ($Y \simeq 2.6'$)

ii) PAPER MILL POND DAM:

FROM APPROX. ROUTING (SEE PHASE I REPORT) FOR: $Q_s \simeq 460 H^{3/2}$ AND STORAGE INCREMENT $\Delta S \simeq 106 H_x$ FOR THE ADDITIONAL SURCHARGE (H_x) ABOVE THE INITIAL SURCHARGE $H_o \simeq 5.3'$ ($Q = 5600^{CFS}$) BEFORE THE HANOVER RESERVOIR FAILURE.

APPLYING THE NED-ACE GUIDELINES (SURCHARGE STORAGE ROUTING) THE OUTFLOW OF PAPER MILL POND DAM IS ESTIMATED AT:

$$(Q_{P_3})_2 \simeq 6400^{CFS} \quad (H \simeq 5.8'; H_o \simeq 0.5')$$

iii) LITTLE RIVER D/S FROM PAPER MILL POND DAM:

FROM THE ACE PAPER MILL POND DAM PHASE I REPORT, THE LITTLE RIVER CHANNEL D/S FROM THIS DAM IS TRAPEZOIDAL ($\simeq$) 50' WIDE AND WITH 25" AND 8" TO 1' SIDE SLOPES. THEREFORE, ASSUMING ($n \simeq 0.050$) AND THE LONGITUDINAL CHANNEL SLOPE TO NEARMIGGES POND OF ($\simeq$) $S = 0.5\%$, THE FLOW AND STAGE AT ANY POTENTIAL JUNCT

AREA D/S FROM PAPER MILL POND DAM ARE ESTIMATED AT

$(Q_{P_s})_3 \leq 6400$ CFS $\quad (y_s)_3 \leq 7.1'$

d) APPROXIMATE STAGE BEFORE FAILURE D/S FROM PAPER MILL POND DAM:

$Q_s = \sqrt{600}$ CFS $\therefore y_s \approx 6.7'$

e) RAISE IN STAGE D/S FROM PAPER MILL POND DAM: $\Delta y \approx 0.4'$

III / SELECTION OF TEST FLOOD

1) CLASSIFICATION OF DAM ACCORDING TO NED-ACE GUIDELINES:

a) SIZE: *STORAGE (MAX) ≈ 400 AC FT (50 < S < 1000 AC FT)
*HEIGHT ≈ 26.5' (25 < H < 40 FT)

*STORAGE: SEE p. D-8 ; HEIGHT: SEE p. D-7

∴ SIZE CLASSIFICATION: SMALL

b) HAZARD POTENTIAL: AS A RESULT OF THE D/S FAILURE ANALYSIS AND IN VIEW OF THE IMPACT THAT FAILURE OF HANOVER RESERVOIR DAM MAY HAVE ON THE POTENTIAL IMPACT AREA (p. D-7), THE DAM IS CLASSIFIED AS HAVING:

HAZARD CLASSIFICATION: SIGNIFICANT

2) TEST FLOOD: ½ PMF ≈ 10800 CFS

THIS SELECTION IS BASED ON THE RESULTS OF THE PREVIOUS ANALYSIS AND CLASSIFICATION.

HANOVER RESERVOIR DAM

IV) SUMMARY

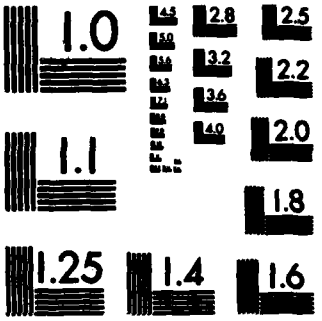
1) TEST FLOOD = ½ PMF ≈ 10800 CFS
(PARALLEL COMPUTATIONS HAVE BEEN MADE FOR PMF = 21600 CFS AND ARE ALSO SUMMARIZED BELOW)

2) PERFORMANCE AT PEAK FLOOD CONDITIONS:
a) PEAK INFLOWS: Q_{P_1} = PMF = 21600 CFS Q'_{P_1} = ½ PMF = 10800 CFS
b) PEAK OUTFLOWS: Q_{P_2} ≈ 21400 CFS Q'_{P_2} ≈ 10700 CFS
c) SPILLWAY CAPACITY: (SEE TABLE P. D-6)
d) PERFORMANCE:
i) AT TEST FLOOD: OVERTOPPED (±) 1.5' (W.S. ELEV. 191.1' NGVD)
ii) AT PMF: OVERTOPPED (±) 3.4' (W.S. ELEV. 193.0' NGVD)

3) DOWNSTREAM FAILURE CONDITIONS:
a) PEAK FAILURE OUTFLOW: Q_{P_1} ≈ 72000 CFS
b) FLOOD DEPTH IMMEDIATELY D/S FROM DAM: Y_0 ≈ 11.7'
c) CONDITIONS D/S FROM HANOVER RES. DAM TO PAPER MILL POND:
STAGE BEFORE FAILURE Y_2 ≈ 2.2' (Q_2 ≈ 5600 CFS)
STAGE AFTER FAILURE (Y_3): SEE TABLE P. D-9
RAISE IN STAGE AFTER FAILURE (ΔY): VARIES FROM (±) 9.5' TO 0.4'
d) CONDITIONS AT PAPER MILL POND DAM:
SURCHARGE BEFORE FAILURE: H_2 ≈ 5.3' (Q_2 ≈ 5600 CFS; (±) 1.2' FREEBOARD)
SURCHARGE AFTER FAILURE: H_3 ≈ 5.8' (Q_{P_2} ≈ 7800 CFS; Q_{P_3} ≈ 6400 CFS; (±) 0.7' FREEBD.)
e) CONDITIONS D/S FROM PAPER MILL POND DAM.
STAGE BEFORE FAILURE: Y_2 ≈ 6.7' (Q_2 ≈ 5600 CFS)
STAGE AFTER FAILURE: Y_3 ≈ 7.1' (Q_3 ≈ 6400 CFS)

AD-A144 697 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
HANOVER RESERVOIR DAM.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV AUG 80

UNCLASSIFIED F/G 13/13 NL



PRELIMINARY GUIDANCE

FOR ESTIMATING

MAXIMUM PROBABLE DISCHARGES

IN

PHASE I DAM SAFETY

INVESTIGATIONS

New England Division
Corps of Engineers

March 1978

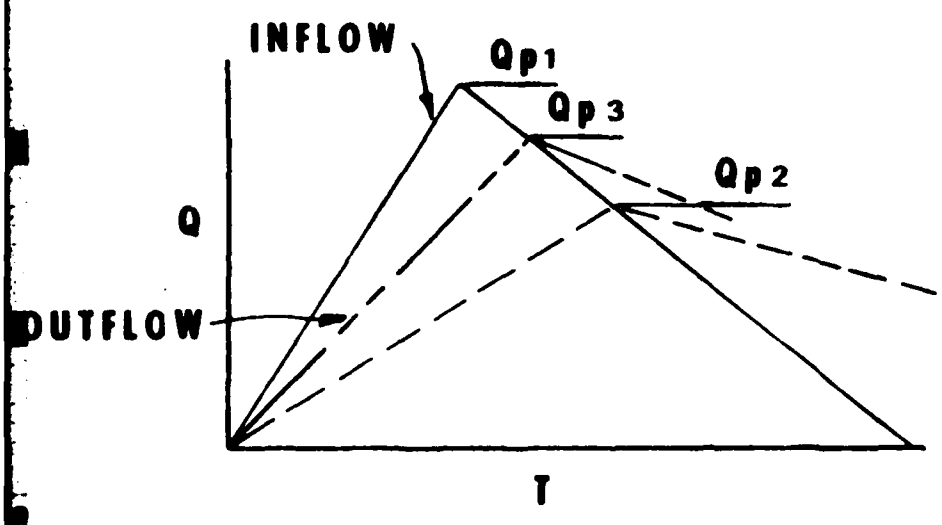
MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

	River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1.	Pawtuxet River	19,000	200	190
2.	Mill River (R.I.)	8,500	34	500
3.	Peters River (R.I.)	3,200	13	490
4.	Kettle Brook	8,000	30	530
5.	Sudbury River.	11,700	86	270
6.	Indian Brook (Hopk.)	1,000	5.9	340
7.	Charles River.	6,000	184	65
8.	Blackstone River.	43,000	416	200
9.	Quinebaug River	55,000	331	330

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

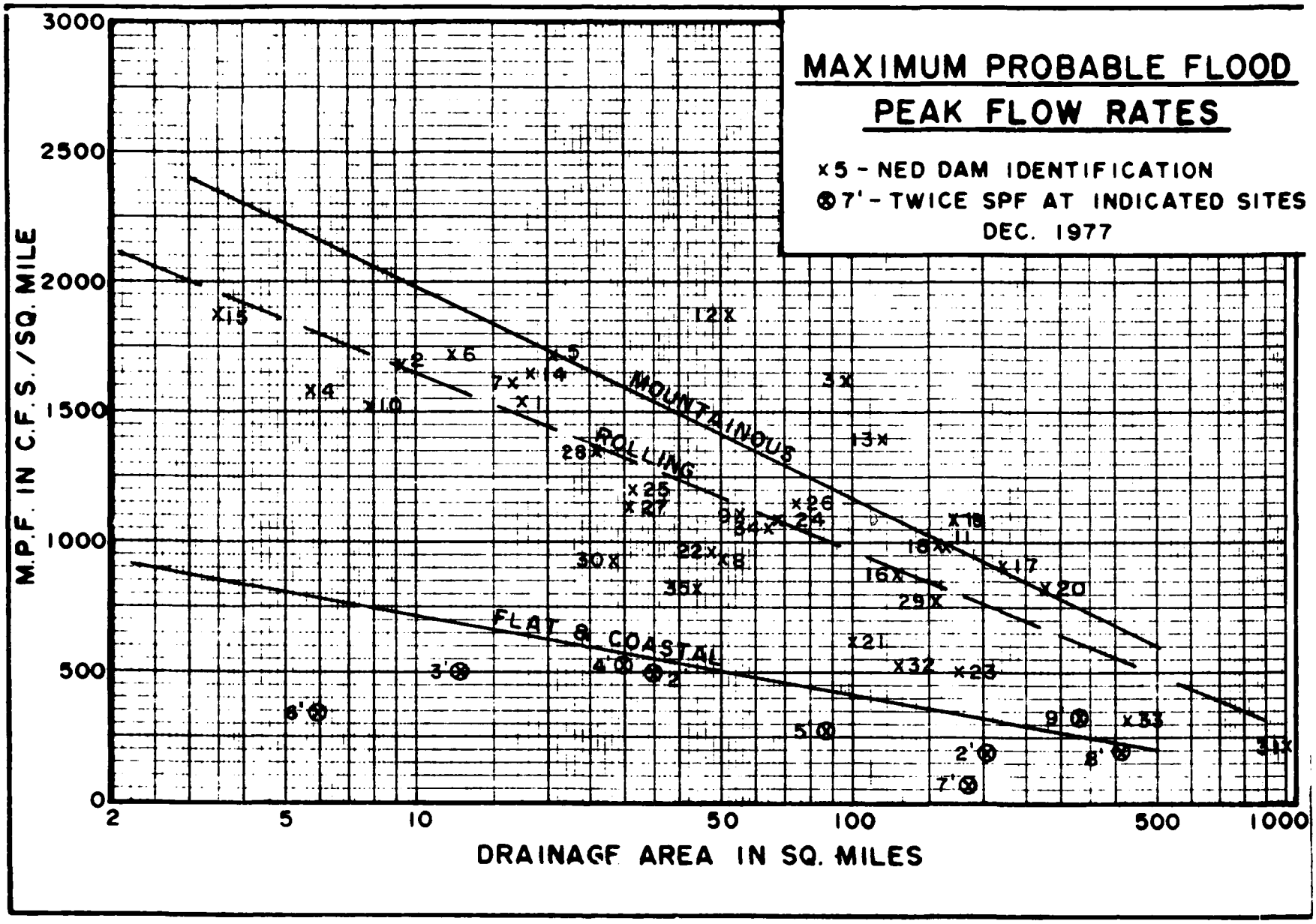
b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore:

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".


MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITES
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
1000
MOUNTAINOUS
ROLLING
FLAT & COASTAL
x15
x4
x10
x2
x6
x5
7x
x14
x1
12x
3x
13x
28x
x25
x27
x26
9x
34x
x24
x18
18x
x17
x20
22x
x8
30x
16x
29x
35x
x21
x32
x23
3⊗
4⊗
2
6'⊗
5⊗
9⊗
x33
2'⊗
8'⊗
7'⊗
31x

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

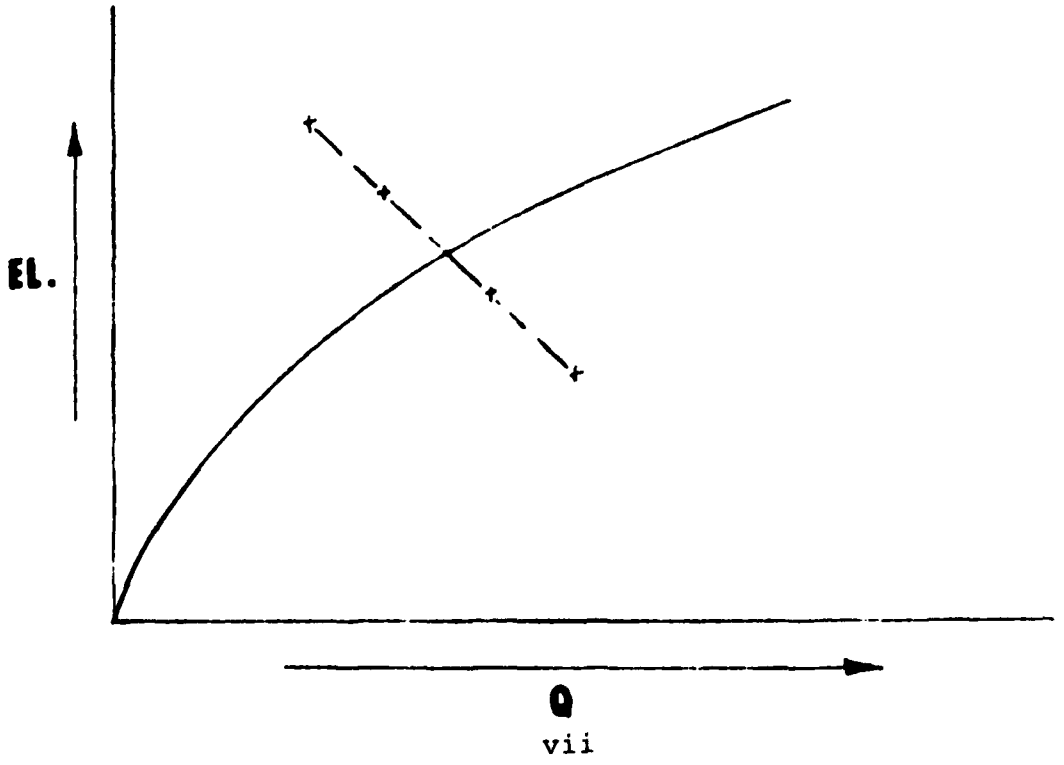
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

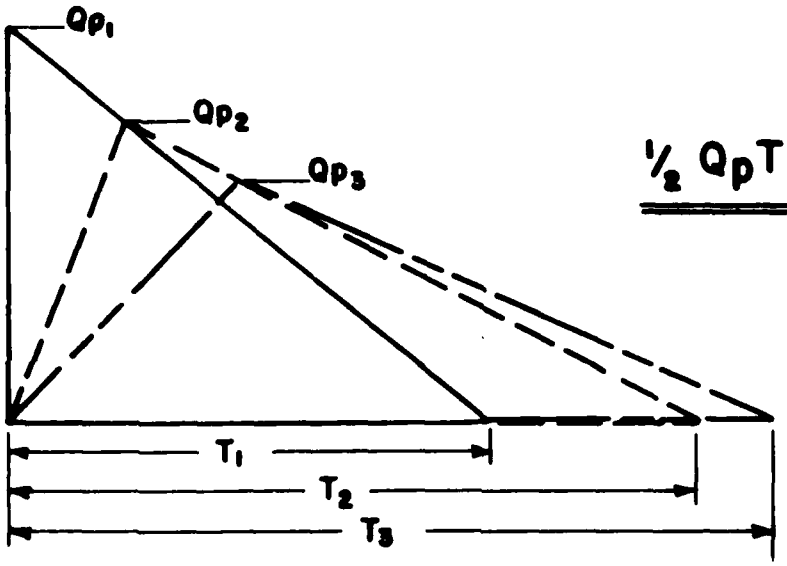
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19" R.O.

Q_{p2} STOR EL.



"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Q_{p_1} = \frac{8}{27} W_b \sqrt{g} Y_o^{3/2}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Q_{p_2}(\text{TRIAL}) = Q_{p_1}\left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Q_{p_2} = Q_{p_1}\left(1 - \frac{V_{1\text{and}2}}{S}\right)$$

STEP 5: *FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.*

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NATIONAL ID NUMBER	INVENTORY	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
CT	00870	NED	09	011	02			HANOVER RESERVOIR DAM	4130.9	7203.8	19	FEB	74

POPULAR NAME	NAME OF IMPOUNDMENT
	HANOVER RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	07	LITTLE RIVER	HANOVER	1	900

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST DWR FED H PRV/FED SCS A VOL/DATE
EART	1870	H	24	2	220	200	NED

REMARKS

20-ESTIMATE 21-STONE 22-ESTIMATE

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)

OWNER	ENGINEERING BY	CONSTRUCTION BY

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION

REMARKS

REPORTS CONTROL SYMBOL
DAEN–CWE–17

END

FILMED

DTIC